723 Physics 1 questions

CLO1 Units, sig fig etc

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Convert 1.2×10^{-3} to decimal notation. 1) _____

A) 1.200 B) 0.1200 C) 0.0120 D) 0.0012 E) 0.00012

2) Write out the number 7.35×10^{-5} in full with a decimal point and correct number of zeros. 2) _____

A) 0.00000735

B) 0.0000735

C) 0.000735

D) 0.00735

E) 0.0735

3) 0.0001776 can also be expressed as 3) _____

A) 1.776×10^{-3}.

B) 1.776×10^{-4}.

C) 17.72×10^{4}.

D) 1772×10^{5}.

E) 177.2×10^{7}.

4) 0.00325×10^{-8} cm can also be expressed in mm as 4) _____

A) 3.25×10^{-12} mm.

B) 3.25×10^{-11} mm.

C) 3.25×10^{-10} mm.

D) 3.25×10^{-9} mm.

E) 3.25×10^{-8} mm.

5) If, in a parallel universe, π has the value 3.14149, express π in that universe to four significant figures. 5) _____

A) 3.141 B) 3.142 C) 3.1415 D) 3.1414

6) The number 0.003010 has 6) _____

A) 7 significant figures. B) 6 significant figures.

C) 4 significant figures. D) 2 significant figures.

7) What is $\frac{0.674}{0.74}$ to the proper number of significant figures? 7) _____

A) 0.911 B) 0.9 C) 0.91 D) 0.9108

8) What is the value of $\pi(8.104)^2$, written with the correct number of significant figures? 8) _____

A) 206.324 B) 206.323 C) 206.3 D) 206 E) 200

9) What is the sum of 1123 and 10.3 written with the correct number of significant figures? 9) _____

A) 1.13×10^{3} B) 1133 C) 1.1×10^{3} D) 1133.3 E) 1133.3000

10) What is the sum of 1.53 + 2.786 + 3.3 written with the correct number of significant figures? 10) _____

A) 8 B) 7.6 C) 7.62 D) 7.616 E) 7.6160

11) What is the difference between 103.5 and 102.24 written with the correct number of significant figures? 11) _____

A) 1 B) 1.3 C) 1.26 D) 1.260 E) 1.2600

12) What is the product of 11.24 and 1.95 written with the correct number of significant figures? 12) _____
A) 22 B) 21.9 C) 21.92D) 21.918 E) 21.9180

13) What is the result of 1.58 ÷ 3.793 written with the correct number of significant figures? 13) _____
A) 4.2×10^{-1}
B) 4.1656×10^{-1}
C) 4.166×10^{-1}
D) 4×10^{-1}
E) 4.17×10^{-1}

14) What is 34 + (3) × (1.2465) written with the correct number of significant figures? 14) _____
A) 37.7 B) 37.7395 C) 4×10^{1} D) 38 E) 37.74

15) What is 56 + (32.00)/(1.2465 + 3.45) written with the correct number of significant figures? 15) _____
A) 62.81
B) 62.8123846
C) 62.812
D) 63
E) 62.8

16) Add $3685\,\text{g}$ and $66.8\,\text{kg}$ and express your answer in milligrams (mg). 16) _____
A) 7.05×10^{5} mg B) 7.05×10^{6} mg C) 7.05×10^{7} mg D) 7.05×10^{4} mg

17) Express $(4.3 \times 10^{6})^{-1/2}$ in scientific notation. 17) _____
A) 2.1×10^{4} B) 2.1×10^{3} C) 2.1×10^{-5} D) 4.8×10^{-4}

18) What is $0.205^{2/3}$, expressed to the proper number of significant figures? 18) _____
A) 0.3477 B) 0.3 C) 0.35 D) 0.348

19) The length and width of a rectangle are 1.125 m and 0.606 m, respectively. Multiplying, your calculator gives the product as 0.68175. Rounding properly to the correct number of significant figures, the area should be written as 19) _____

A) 0.7 m^2.
B) 0.68 m^2.
C) 0.682 m^2.
D) 0.6818 m^2.
E) 0.68175 m^2.

20) The following exact conversion equivalents are given: 1 m = 100 cm , 1 in = 2.54 cm, and $1\text{ ft} = 12\text{ in.}$ If a computer screen has an area of 1.27 ft^2, this area is closest to 20) _____

A) 0.0465 m^2.

B) 0.284 m^2.

C) 0.00284 m^2.

D) 4.65 m^2.

E) 0.118 m^2.

21) In addition to 1 m = 39.37 in., the following exact conversion equivalents are given: $1\text{ mile} = 5280\text{ ft}$, $1\text{ ft} = 12\text{ in}$, $1\text{ hour} = 60\text{ min}$, and 1 min = 60 s. If a particle has a velocity of 8.4 miles per hour,its velocity, in m/s, is closest to 21) _____

A) 3.0 m/s. B) 4.5 m/s. C) 3.4 m/s. D) 3.8 m/s. E) 4.1 m/s.

22) A weight lifter can bench press 171 kg. How many milligrams (mg) is this? 22) _____

A) 1.71×10^8 mg B) 1.71×10^9 mg C) 1.71×10^7 mg D) 1.71×10^6 mg

23) How many nanoseconds does it take for a computer to perform one calculation if it performs 6.7×10^7 calculations per second? 23) _____

A) 15 ns B) 65 ns C) 67 ns D) 11 ns

24) The shortest wavelength of visible light is approximately 400 nm. Express this wavelength in centimeters. 24) _____

A) 4×10^{-5} cm
B) 4×10^{-9} cm
C) 4×10^{-7} cm
D) 400×10^{-11} cm
E) 4×10^{-11} cm

25) The wavelength of a certain laser is 0.35 micrometers, where $1\text{ micrometer} = 1 \times 10^{-6}\text{ m}$. Express this wavelength in nanometers. 25) _____

A) 3.5×10^4 nm B) 3.5×10^3 nm C) 3.5×10^1 nm D) 3.5×10^2 nm

26) A certain CD-ROM disk can store approximately 6.0×10^2 megabytes of information, where 10^6 bytes = 1 megabyte. If an average word requires 9.0 bytes of storage, how many words can be stored on one disk? 26) _____

A) 2.1×10^7 words B) 2.0×10^9 words C) 6.7×10^7 words D) 5.4×10^9 words

27) A plot of land contains 5.8 acres. How many square meters does it contain? $[1\text{ acre} = 43{,}560\text{ ft}^2]$ 27) _____

A) 7.1×10^3 m^2 B) 7.0×10^4 m^2 C) 5.0×10^4 m^2 D) 2.3×10^4 m^2

28) A person on a diet loses 1.6 kg in a week. How many $\text{micrograms/second } (\mu\text{g/s})$ are lost? 28) _____

A) 1.6×10^5 μg/s B) 2.6×10^3 μg/s C) 44 μg/s D) 6.4×10^4 μg/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

29) Albert uses as his unit of length (for walking to visit his neighbors or plowing his fields) the albert (A), the distance Albert can throw a small rock. One albert is 92 meters. How many square alberts is equal to one acre? (1 acre = 43,560 ft^2 = 4050 m^2) 29) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

30) Convert a speed of 4.50 km/h to units of ft/min. (1.00 m = 3.28 ft) 30) _____

A) 246 ft/min
B) 0.246 ft/min
C) 886 ft/min
D) 82.3 ft/min
E) 165 ft/min

31) The exhaust fan on a typical kitchen stove pulls 600 CFM (cubic feet per minute) through the filter. Given that 1.00 in. = 2.54 cm, how many cubic meters per second does this fan pull? 31) _____

A) 0.328 m^3/sec B) 0.283 m^3/sec C) 3.05 m^3/sec D) 32.8 m^3/sec

32) The mass of a typical adult woman is closest to 32) _____

A) 20 kg. B) 150 kg. C) 75 kg. D) 35 kg.

33) The height of the ceiling in a typical home, apartment, or dorm room is closest to 33) _____

A) 100 cm. B) 200 cm. C) 400 cm. D) 500 cm.

34) Approximately how many times does an average human heart beat in a year? 34) _____

A) 4×10^9 B) 4×10^7 C) 4×10^6 D) 4×10^5 E) 4×10^8

35) Approximately how many times does an average human heart beat in a lifetime? 35) _____

A) 3×10^{11} B) 3×10^9 C) 3×10^8 D) 3×10^{10} E) 3×10^7

36) Approximately how many pennies would you have to stack to reach an average 8-foot ceiling? 36) _____

A) 2×10^6 B) 2×10^2 C) 2×10^5 D) 2×10^3 E) 2×10^4

37) Estimate the number of times the earth will rotate on its axis during a human's lifetime. 37) _____

A) 3×10^5 B) 3×10^4 C) 3×10^6 D) 3×10^8 E) 3×10^7

38) Estimate the number of pennies that would fit in a box one foot long by one foot wide by one foot tall. 38) _____

A) 5×10^4 B) 5×10^2 C) 5×10^5 D) 5×10^6 E) 5×10^3

39) A marathon is $26\,\text{mi}$ and $385\,\text{yd}$ long. Estimate how many strides would be required to run a marathon. Assume a reasonable value for the average number of feet/stride. 39) _____

A) 4.5×10^3 strides B) 4.5×10^4 strides C) 4.5×10^6 strides D) 4.5×10^5 strides

40) The period of a pendulum is the time it takes the pendulum to swing back and forth once. If the only dimensional quantities that the period depends on are the acceleration of gravity, g, and the length of the pendulum, ℓ, what combination of g and ℓ must the period be proportional to? (Acceleration has SI units of $\text{m} \cdot \text{s}^{-2}$.). 40) _____

A) $\sqrt{\ell g}$ B) $g\ell^2$ C) $g\ell$ D) g/ℓ E) $\sqrt{g\ell}$

41) The speed of a wave pulse on a string depends on the tension, F, in the string and the mass per unit length, μ, of the string. Tension has SI units of $\text{kg} \cdot \text{m} \cdot \text{s}^{-2}$ and the mass per unit length has SI units of $\text{kg} \cdot \text{m}^{-1}$. What combination of F and μ must the speed of the wave be proportional to? 41) _____

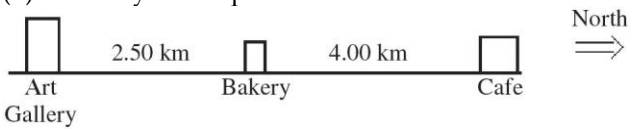
A) F / μ B) $\sqrt{\mu / F}$ C) μ / F D) $\sqrt{F / \mu}$ E) $\sqrt{\mu F}$

CLO3 2-3D motion

42) The position x, in meters, of an object is given by the equation $x = A + Bt + Ct^2$, where t represents time in seconds. What are the SI units of A, B, and C? 42) _____

A) m, m/s, m/s^2
B) m, s, s^2
C) m/s, m/s^2, m/s^3
D) m, s, s
E) m, m, m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
43) If, in the figure, you start from the Bakery, travel to the Cafe, and then to the Art Gallery
(a) what distance you have traveled?
(b) what is your displacement?



43) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
44) An object moves 15.0 m north and then 11.0 m south. Find both the distance it has traveled and the magnitude of its displacement. 44) _____

A) 26.0 m, 26.0 m B) 4.0 m, 26.0 m C) 4.0 m, 4.0 m D) 26.0 m, 4.0 m

45) What must be your average speed in order to travel 350 km in 5.15 h? 45) _____
A) 66.0 km/h B) 69.0 km/h C) 68.0 km/h D) 67.0 km/h

46) A runner ran the marathon (approximately 42.0 km) in 2 hours and 57 min. What was the average speed of the runner in m/s? 46) _____

A) 124 m/s B) 14.2 m/s C) 14,200 m/s D) 3.95 m/s

47) A light-year is the distance that light travels in one year. The speed of light is 3.00×10^8 m/s. How many miles are there in one light-year? (1 mi = 1609 m, 1 y = 365 d) 47) _____

A) 5.88×10^{15} mi B) 5.88×10^{12} mi C) 9.46×10^{15} mi D) 9.46×10^{12} mi

48) If you are driving 72 km/h along a straight road and you look to the side for 4.0 s, how far do you travel during this inattentive period? 48) _____

A) 80 m B) 20 m C) 18 m D) 40 m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
49) If you run a complete loop around an outdoor track of length 400 m in 100 s, find your
(a) average velocity and (b) average speed. 49) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

50) A polar bear starts at the North Pole. It travels 1.0 km south, then 1.0 km east, and then 1.0 km north to return to its starting point. This trip takes 45 min. What was the bear's average speed? 50) _____

A) 4.0 km/h B) 5.3 km/h C) 0.067 km/h D) 0.00 km/h

51) A polar bear starts at the North Pole. It travels 1.0 km south, then 1.0 km east, and then 1.0 km north to return to its starting point. This trip takes 45 min. What was the bear's average velocity? 51) _____

A) 0.067 km/h B) 5.3 km/h C) 4.0 km/h D) 0.00 km/h

52) You are driving home on a weekend from school at 55 mi/h for 110 miles. It then starts to snow and you slow to 35 mi/h. You arrive home after driving 4 hours and 15 minutes. How far is your hometown from school? 52) _____

A) 180 mi B) 190 mi C) 210 mi D) 200 mi

53) A motorist travels 160 km at 80 km/h and 160 km at 100 km/h. What is the average speed of the motorist for this trip? 53) _____

A) 89 km/h B) 84 km/h C) 91 km/h D) 90 km/h

54) A motorist travels for 3.0 h at 80 km/h and 2.0 h at 100 km/h. What is her average speed for the trip? 54) _____

A) 85 km/h B) 92 km/h C) 88 km/h D) 90 km/h

55) An airplane travels at 300 mi/h south for 2.00 h and then at 250 mi/h north for 750 miles. What is the average speed for the trip? 55) _____

A) 275 mi/h B) 270 mi/h C) 260 mi/h D) 280 mi/h

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

56) A race car circles 10 times around a circular 8.0-km track in 20 min. Using SI units
(a) what is its average speed for the ten laps?
(b) what is its average velocity for the ten laps? 56) _____

57) A bat, flying toward the east at 2.0 m/s, emits a shriek that is reflected back to it from a wall that is 20.0 m in front of the bat at the instant the shriek is emitted. Sound travels at 340 m/s in the air. How many milliseconds after emitting the shriek does the bat hear the reflected echo from the wall?57) _____

58) If, in the figure, you start from the Bakery, travel to the Cafe, and then to the Art Gallery in 2.00 hours, what is your
(a) average speed?
(b) average velocity?

58) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

59) A runner runs around a track consisting of two parallel lines 96 m long connected at the ends by two semicircles with a radius of 49 m. She completes one lap in 100 seconds. What is her average velocity? 59) _____

A) 5.0 m/s B) 10 m/s C) 2.5 m/s D) 1.3 m/s E) 0 m/s

60) A runner runs around a track consisting of two parallel lines 96 m long connected at the ends by two semicircles with a radius of 49 m. She completes one lap in 100 seconds. What is her average speed? 60) _____

A) 2.5 m/s B) 5.0 m/s C) 10 m/s D) 1.3 m/s E) 0 m/s

61) You leave on a 549-mi trip in order to attend a meeting that will start 10.8 h after you begin your trip. Along the way you plan to stop for dinner. If the fastest you can safely drive is 65 mi/h, what is the longest time you can spend over dinner and still arrive just in time for the meeting? 61) _____

A) 2.6 h B) 1.9 h
C) 2.4 h D) You can't stop at all.

62) A motorist makes a trip of 180 miles. For the first 90 miles she drives at a constant speed of 30 mph. At what constant speed must she drive the remaining distance if her average speed for the total trip is to be 40 mph? 62) _____

A) 52.5 mph B) 50 mph C) 60 mph D) 45 mph E) 55 mph

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

63) Human reaction times are worsened by alcohol. How much *further* (in feet) would a drunk driver's car travel before he hits the brakes than a sober driver's car? Assume that both are initially traveling at 50.0 mi/h and their cars have the same acceleration while slowing down, and that the sober driver takes 0.33 s to hit the brakes in a crisis, while the drunk driver takes 1.0 s to do so. (5280 ft = 1 mi) 63) _____

64) Arthur and Betty start walking toward each other when they are 100 m apart. Arthur has a speed of 3.0 m/s and Betty has a speed of 2.0 m/s. How long does it take for them to meet? 64) _____

65) The position $x(t)$ of a particle as a function of time t is given by the equation $x(t) = (3.5\text{ m/s})t - (5.0\text{ m/s}^2)t^2$. What is the average velocity of the particle between $t = 0.30$ s and $t = 0.40$ s? 65) _____

66) A water rocket can reach a speed of 75 m/s in 0.050 seconds from launch. What is its average acceleration? 66) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

67) An airplane increases its speed at the average rate of 15 m/s^2. How much time does it take to increase its speed from 100 m/s to 160 m/s? 67) _____

A) 4.0 s B) 0.058 s C) 0.25 s D) 17 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

68) The captain orders his starship to accelerate from rest at a rate of "1 g" (1 g = 9.8 m/s^2). How many days does it take the starship to reach 10% the speed of light? (Light travels at 3.0×10^8 m/s.) 68) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

69) 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. 69) _____

A) 2.7 m/s^2, north B) 0.30 m/s^2, south

C) 2.7 m/s^2, south D) 0.30 m/s^2, north

70) 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? 70) _____

A) 1300 m/s^2 B) 2800 m/s^2 C) 200 m/s^2 D) 0 m/s^2 E) 1500 m/s^2

71) The velocity $v(t)$ of a particle as a function of time is given by $v(t) = (2.3 \text{ m/s}) + (4.1 \text{ m/s}^2)t - (6.2 \text{ m/s}^3)t^2$. What is the average acceleration of the particle between $t = 1.0$ s and $t = 2.0$ s?71) _____

A) -13 m/s^2 B) 0 m/s^2 C) -15 m/s^2 D) 13 m/s^2 E) 15 m/s^2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

72) If a car accelerates at a uniform 4.0 m/s^2, how long will it take to reach a speed of 80 km/hr, starting from rest? 72) _____

73) A car that is initially moving at 7.50 m/s begins to accelerate forward uniformly at 0.550 m/s^2.
(a) How long after beginning to accelerate does it take the car to move 3.50 km?
(b) How fast is the car moving just as it has traveled 3.50 km? 73) _____

74) An auto accelerates forward from 7.0 m/s at a uniform 0.71 m/s^2. It travels a distance of 1.033 km while accelerating.
(a) How fast is the auto moving just as it is traveled the 1.033 km?
(b) How many seconds did it take to travel the 1.033 km?74) _____

75) In a ballistics test, a bullet moving horizontally with a speed of 500 m/s strikes a sandbag and penetrates a distance of 10.0 cm.
(a) What is the magnitude of the average acceleration of the bullet in the sandbag?
(b) How many milliseconds does it take the bullet to come to rest in the sandbag?75) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

76) A certain test car can go from rest to 32.0 m/s in 3.88 s. The same car can come to a full stop from that speed in 4.14 s. What is the ratio of the magnitude of the starting acceleration to the stopping acceleration? 76) _____

A) 0.937 B) 1.14 C) 1.07 D) 0.878

77) 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? 77) _____

A) 4.2 s B) 30 s C) 45 s D) 15 s

78) 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? 78) _____

A) 20 m/s B) 16 m/s C) 10 m/s D) 12 m/s

79) 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? 79) _____

A) 45 m/s B) 375 m/s C) 30 m/s D) 15 m/s

80) 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? 80) _____

A) 66 m B) 80 m C) 10 m D) 55 m

81) A jet plane is launched from a catapult on an aircraft carrier. In 2.0 s it reaches a speed of 42 m/s at the end of the catapult. Assuming the acceleration is constant, how far did it travel during those 2.0 s? 81) _____

A) 16 m B) 42 m C) 84 m D) 24 m

82) A car starting from rest accelerates at a constant 2.0 m/s^2 for 10 s. It then travels with constant speed it has achieved for another 10 s. Then it finally slows to a stop with constant acceleration of magnitude 2.0 m/s^2. How far does it travel after starting? 82) _____

A) 500 m B) 300 m C) 400 m D) 200 m

83) A car increases its forward velocity uniformly from 40 m/s to 80 m/s while traveling a distance of 200 m. What is its acceleration during this time? 83) _____

A) 9.6 m/s^2 B) 12 m/s^2 C) 24 m/s^2 D) 8.0 m/s^2

84) An object starts from rest and undergoes uniform acceleration. During the first second it travels 5.0 m. How far will it travel during the third second? 84) _____

A) 15 m B) 25 m C) 45 m D) 5.0 m

85) An object is moving in a straight line with constant acceleration. Initially it is traveling at 16 m/s. Three seconds later it is traveling at 10 m/s. How far does it move during this time? 85) _____

A) 48 m B) 39 m C) 57 m D) 30 m

86) A car starts from rest and accelerates uniformly at 3.0 m/s^2 toward the north. A second car starts from rest 6.0 s later at the same point and accelerates uniformly at 5.0 m/s^2 toward the north. How long after the second car starts does it overtake the first car? 86) _____

A) 12 s B) 21 s C) 24 s D) 19 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

87) A car with good tires on a dry road can decelerate (slow down) at a steady rate of about 5.0 m/s^2 when braking. If a car is initially traveling at 55 mi/h
(a) how much time does it take the car to stop?
(b) what is its stopping distance? 87) _____

88) At the instant a traffic light turns green, a car that has been waiting at the intersection starts ahead with a constant acceleration of 2.00 m/s^2. At that moment a truck traveling with a constant velocity of 15.0 m/s overtakes and passes the car.
(a) Calculate the time necessary for the car to reach the truck.
(b) Calculate the distance beyond the traffic light that the car will pass the truck.
(c) Determine the speed of the car when it passes the truck. 88) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

89) Starting from rest, a dragster travels a straight 1/4 mi racetrack in 6.70 s with constant acceleration. What is its velocity when it crosses the finish line? 89) _____

A) 135 mi/h B) 188 mi/h C) 296 mi/h D) 269 mi/h

90) A bicyclist starts a timed race at $6.0\ \text{mi/h}$. In order to win, he must average $21\ \text{mi/h}$. Assuming constant acceleration from the start, how fast must he be traveling at the end of the race? 90) _____

A) 42 mi/h B) 24 mi/h C) 36 mi/h D) 30 mi/h

91) A car accelerates from $5.0\ \text{m/s}$ to $21\ \text{m/s}$ at a constant rate of $3.0\ \text{m/s}^2$. How far does it travel while accelerating? 91) _____

A) 69 m B) 117 m C) 207 m D) 41 m

92) An airplane needs to reach a forward velocity of $203.0\ \text{km/h}$ to take off. On a 2000–m runway, what is the minimum uniform acceleration necessary for the plane to take flight if it starts from rest? 92) _____

A) 1.0 m/s^2 B) 0.79 m/s^2 C) 0.87 m/s^2 D) 0.95 m/s^2

93) Assuming equal rates of uniform acceleration in both cases, how much further would you travel if braking from $56\ \text{mi/h}$ to rest than from $28\ \text{mi/h}$? 93) _____

A) 4 times farther B) 3.2 times farther
C) 5.2 times farther D) 4.8 times farther

94) Acceleration is sometimes expressed in multiples of g, where $g = 9.8\ \text{m/s}^2$ is the acceleration of an object due to the earth's gravity. In a car crash, the car's forward velocity may go from $29\ \text{m/s}$ to $0\ \text{m/s}$ in $0.15\ \text{s}$. How many g's are experienced, on average, by the driver? 94) _____

A) 24 g B) 14 g C) 20 g D) 26 g

95) A baseball is hit with a bat and, as a result, its direction is completely reversed and its speed is doubled. If the actual contact with the bat lasts 0.45 s, what is the ratio of the magnitude of the average acceleration of the ball to its original speed? 95) _____

A) 6.7 s^{-1} B) 0.15 s^{-1} C) 4.4 s^{-1} D) 2.2 s^{-1}

96) A train starts from rest and accelerates uniformly until it has traveled 5.6 km and acquired a forward velocity of $42\ \text{m/s}$. The train then moves at a constant velocity of $42\ \text{m/s}$ for 420 s. The train then slows down uniformly at $0.065\ \text{m/s}^2$, until it is brought to a halt. The acceleration during the first 5.6 km of travel is closest to which of the following? 96) _____

A) 0.17 m/s^2 B) 0.19 m/s^2 C) 0.16 m/s^2 D) 0.14 m/s^2 E) 0.20 m/s^2

97) A train starts from rest and accelerates uniformly until it has traveled 2.1 km and acquired a forward velocity of $24\ \text{m/s}$. The train then moves at a constant velocity of $24\ \text{m/s}$ for 400 s. The train then slows down uniformly at $0.065\ \text{m/s}^2$, until it is brought to a halt. The distance traveled by the train while slowing down is closest to 97) _____

A) 4.4 km. B) 3.8 km. C) 3.6 km. D) 4.0 km. E) 4.2 km.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

98) A soccer ball is released from rest at the top of a grassy incline. After 6.4 seconds the ball has rolled 91 m with constant acceleration, and 1.0 s later it reaches the bottom of the incline.
(a) What was the ball's acceleration?
(b) How long was the incline? 98) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

99) A car starts from rest and accelerates at a steady 6.00 m/s^2. How far does it travel in the first 3.00 s? 99) _____
A) 36.0 m B) 54.0 m C) 18.0 m D) 9.00 m E) 27.0 m

100) A car is moving with a constant acceleration. At time t = 5.0 s its velocity is 8.0 m/s in the forward direction, and at time t = 8.0 s its velocity is 12.0 m/s forward. What is the distance traveled in that interval of time? 100) _____

A) 20 m B) 50 m C) 30 m D) 40 m E) 10 m

101) 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? 101) _____

A) 4320 m/s B) 93.0 m/s C) 65.7 m/s D) 186 m/s E) 37.0 m/s

102) A car is moving with a speed of 32.0 m/s. The driver sees an accident ahead and slams on the brakes, causing the car to slow down with a uniform acceleration of magnitude 3.50 m/s^2. How far does the car travel after the driver put on the brakes until it comes to a stop? 102) _____

A) 146 m B) 112 m C) 9.14 m D) 292 m E) 4.57 m

103) A car is traveling with a constant speed when the driver suddenly applies the brakes, causing the car to slow down with a constant acceleration of magnitude 3.50 m/s^2. If the car comes to a stop in a distance of 30.0 m, what was the car's original speed? 103) _____

A) 105 m/s B) 315 m/s C) 210 m/s D) 10.2 m/s E) 14.5 m/s

104) A car is traveling with a constant speed of 30.0 m/s when the driver suddenly applies the brakes, causing the car to slow down with a constant acceleration. The car comes to a stop in a distance of 120 m. What was the acceleration of the car as it slowed down? 104) _____

A) 4.25 m/s^2 B) 4.50 m/s^2 C) 4.75 m/s^2 D) 3.75 m/s^2 E) 4.00 m/s^2

105) A car is traveling at 26.0 m/s when the driver suddenly applies the brakes, causing the car to slow down with constant acceleration. The car comes to a stop in a distance of 120 m. How fast was the car moving when it was 60.0 m past the point where the brakes were applied? 105) _____

A) 18.4 m/s B) 9.20 m/s C) 12.1 m/s D) 22.5 m/s E) 15.0 m/s

106) Car A is traveling at 22.0 m/s and car B at 29.0 m/s. Car A is 300 m behind car B when the driver of car A accelerates his car with a uniform forward acceleration of 2.40 m/s^2. How long after car A begins to accelerate does it take car A to overtake car B? 106) _____

A) 316 s
B) 19.0 s
C) 12.6 s

D) 5.50 s
E) Car A never overtakes car B.

107) A stone is thrown with an initial upward velocity of 7.0 m/s and experiences negligible air resistance. If we take upward as the positive direction, what is the velocity of the stone after 0.50 s? 107) _____

A) -4.9 m/s B) 0.00 m/s C) 2.1 m/s D) -2.1 m/s E) 4.9 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
108) An astronaut on a strange new planet having no atmosphere finds that she can jump up to a maximum height of 27 m when her initial upward speed is 6.0 m/s. What is the magnitude of the acceleration due to gravity on the planet?
108) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
109) A laser is thrown upward with a speed of 12 m/s on the surface of planet X where the acceleration due to gravity is 1.5 m/s^2 and there is no atmosphere. What is the maximum height reached by the laser? 109) _____

A) 48 m B) 8.0 m C) 18 m D) 144 m

110) A laser is thrown upward with a speed of 12 m/s on the surface of planet X where the acceleration due to gravity is 1.5 m/s^2 and there is no atmosphere. How long does it take for the laser to reach the maximum height? 110) _____

A) 14 s B) 8.0 s C) 16 s D) 11 s

111) An instrument is thrown upward with a speed of 15 m/s on the surface of planet X where the acceleration due to gravity is 2.5 m/s^2 and there is no atmosphere. How long does it take for the instrument to return to where it was thrown?
111) _____

A) 6.0 s B) 12 s C) 8.0 s D) 10 s

112) A hammer is thrown upward with a speed of 14 m/s on the surface of planet X where the acceleration due to gravity is 3.5 m/s^2 and there is no atmosphere. What is the speed of the hammer after 8.0 s? 112) _____

A) 21 m/s B) 64 m/s C) 7.0 m/s D) 14 m/s

113) Human reaction time is usually greater than 0.10 s. If your friend holds a ruler between your fingers and releases it without warning, how far can you expect the ruler to fall before you catch it, assuming negligible air resistance? 113) _____

A) At least 4.9 cm B) At least 3.0 cm C) At least 9.8 cm D) At least 6.8 cm

114) 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?
114) _____

A) 9.8 m/s upward B) 19.6 m/s downward
C) 9.8 m/s downward D) 0 m/s

115) 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? 115) _____

A) 98 m/s B) 49 m/s C) 9.8 m/s D) 25 m/s

116) 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? 116) _____

A) 3.7 s B) 15 s C) 11 s D) 7.3 s

117) A ball is thrown downward from the top of a building with an initial speed of 25 m/s. It strikes the ground after 2.0 s. How high is the building, assuming negligible air resistance? 117) _____

A) 50 m B) 20 m C) 70 m D) 30 m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

118) A ball is thrown straight up with a speed of 30 m/s, and air resistance is negligible.
(a) How long does it take the ball to reach the maximum height?
(b) What is the maximum height reached by the ball?
(c) What is its speed after 4.2 s? 118) _____

119) A foul ball is hit straight up into the air with a speed of 30 m/s, and air resistance is negligible.
(a) Calculate the time required for the ball to rise to its maximum height.
(b) Calculate the maximum height reached by the ball above the point where it hit the bat.
(c) Determine the times at which the ball passes a point 25 m above the point where it was hit by the bat.
(d) Explain why there are two answers to part (c). 119) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

120) A ball is projected upward at time $t = 0$ s, from a point on a flat roof 10 m above the ground. The ball rises and then falls with insignificant air resistance, missing the roof, and strikes the ground. The initial velocity of the ball is $58.5\ \text{m/s}$. Consider all quantities as positive in the upward direction. At time $t = 5.97\ \text{s}$, the vertical velocity of the ball is closest to 120) _____

A) -175 m/s. B) -12 m/s. C) 0 m/s. D) +12 m/s. E) +175 m/s.

121) A ball is projected upward at time $t = 0$ s, from a point on a flat roof 90 m above the ground. The ball rises and then falls with insignificant air resistance, missing the roof, and strikes the ground. The initial velocity of the ball is $80.5\ \text{m/s}$. Consider all quantities as positive in the upward direction. The vertical velocity of the ball when it is $89\ \text{m}$ above the ground is closest to 121) _____

A) -48 m/s. B) -32 m/s. C) -81 m/s. D) -97 m/s. E) -64 m/s.

122) A test rocket at ground level is fired straight up from rest with a net upward acceleration of 20 m/s^2. After 4.0 s, the motor turns off but the rocket continues to coast upward with insignificant air resistance. What maximum elevation does the rocket reach? 122) _____

A) 330 m B) 160 m C) 490 m D) 320 m E) 410 m

123) A toy rocket is launched vertically from ground level at time $t = 0.00$ s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 64 m and acquired an upward velocity of $60\ \text{m/s}$. The rocket continues to rise with insignificant air resistance in unpowered flight, reaches maximum height, and falls back to the ground. The time interval during which the rocket engine provided the upward acceleration, is closest to 123) _____

A) 1.5 s. B) 1.7 s. C) 1.9 s. D) 2.3 s. E) 2.1 s.

124) A toy rocket is launched vertically from ground level at time $t = 0.00$ s. The rocket engine provides constant upward

acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 81 m and acquired an upward velocity of $40\ \text{m/s}$. The rocket continues to rise with insignificant air resistance in unpowered flight, reaches maximum height, and falls back to the ground. The upward acceleration of the rocket during the burn phase is closest to 124) _____

A) 8.7 m/s^2. B) 9.0 m/s^2. C) 9.6 m/s^2. D) 9.3 m/s^2. E) 9.9 m/s^2.

125) A toy rocket is launched vertically from ground level at time $t = 0$ s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 49.0 m and acquired an upward velocity of $60.0\ \text{m/s}$. The rocket continues to rise with insignificant air resistance in unpowered flight, reaches maximum height, and falls back to the ground. The maximum height reached by the rocket is closest to 125) _____

A) 244 m. B) 256 m. C) 209 m. D) 233 m. E) 221 m.

126) A rock is projected upward from the surface of the Moon, at time $t = 0$ s, with an upward velocity of 30.0 m/s. The acceleration due to gravity at the surface of the Moon is 1.62 m/s^2, and the Moon has no atmosphere. The height of the rock when it is descending with a speed of 20.0 m/s is closest to 126) _____

A) 154 m. B) 115 m. C) 125 m. D) 145 m. E) 135 m.

127) A ball is thrown straight upward from ground level with a speed of $18\ \text{m/s}$. How much time passes before the ball strikes the ground if we disregard air resistance? 127) _____

A) 1.1 s B) 1.8 s C) 0.6 s D) 3.7 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

128) A rock is thrown directly upward from the edge of a flat roof of a building that is 56.3 meters tall. The rock misses the building on its way down, and is observed to strike the ground 4.00 seconds after being thrown. Take the acceleration due to gravity to have magnitude $9.80\ \text{m/s}^2$ and neglect any effects of air resistance. With what speed was the rock thrown?
128) _____

129) A package is dropped from a helicopter that is moving upward at $15\ \text{m/s}$. If it takes $8.0\ \text{s}$ before the package strikes the ground, how high above the ground was the package when it was released? Neglect air resistance. 129) _____

130) At the same moment, one rock is dropped and one is thrown downward with an initial velocity of $29\ \text{m/s}$ from the top of a building that is $300\ \text{m}$ tall. How much *earlier* does the thrown rock strike the ground? Neglect air resistance.
130) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

131) An object is dropped from a bridge. A second object is thrown downwards 1.0 s later. They both reach the water 20 m below at the same instant. What was the initial speed of the second object? Neglect air resistance. 131) _____

A) 9.9 m/s B) 4.9 m/s C) 15 m/s D) 21 m/s E) 20 m/s

132) To determine the height of a bridge above the water, a person drops a stone and measures the time it takes for it to hit the water. If the time is 2.3 s, what is the height of the bridge? Neglect air resistance. 132) _____

A) 14 m B) 52 m C) 26 m D) 32 m E) 10 m

133) To determine the height of a bridge above the water, a person drops a stone and measures the time it takes for it to hit the water. If the height of the bridge is 41 m, how long will it take for the stone to hit the water? Neglect air resistance. 133) _____

A) 3.6 s B) 2.6 s C) 3.2 s D) 2.3 s E) 2.9 s

134) An astronaut stands by the rim of a crater on the Moon, where the acceleration of gravity is 1.62 m/s^2 and there is no air. To determine the depth of the crater, she drops a rock and measures the time it takes for it to hit the bottom. If the time is 6.3 s, what is the depth of the crater? 134) _____

A) 26 m B) 38 m C) 14 m D) 32 m E) 10 m

135) An astronaut stands by the rim of a crater on the Moon, where the acceleration of gravity is 1.62 m/s^2 and there is no air. To determine the depth of the crater, she drops a rock and measures the time it takes for it to hit the bottom. If the depth of the crater is 120 m, how long does it take for the rock to fall to the bottom of the crater? 135) _____

A) 29.3 s B) 37.5 s C) 12.2 s D) 3.04 s E) 32.1 s

136) 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. 136) _____

A) 0.52 s B) 3.1 s C) 1.2 s D) 2.4 s E) 4.2 s

137) An object is thrown upwards with a speed of 13 m/s. How long does it take to reach a height of 4.0 m above the projection point while descending? Neglect air resistance. 137) _____

A) 3.1 s B) 0.42 s C) 1.2 s D) 2.3 s E) 4.2 s

138) To determine the height of a flagpole, Abby throws a ball straight up and times it. She sees that the ball goes by the top of the pole after 0.50 s and then reaches the top of the pole again after a total elapsed time of 4.1 s. How high is the pole above the point where the ball was launched? Neglect air resistance. 138) _____

A) 13 m B) 16 m C) 10 m D) 18 m E) 26 m

139) Abby throws a ball straight up and times it. She sees that the ball goes by the top of a flagpole after 0.50 s and reaches the level of the top of the pole after a total elapsed time of 4.1 s. What was the speed of the ball at launch? Neglect air resistance. 139) _____

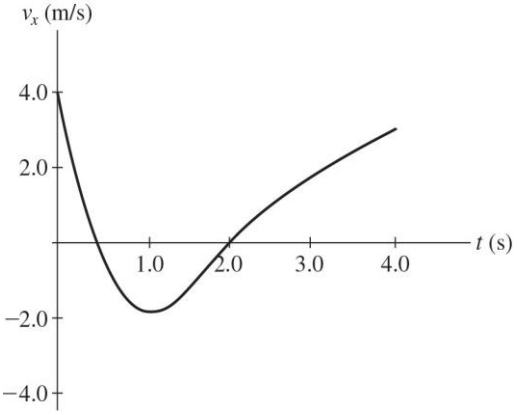
A) 48 m/s B) 45 m/s C) 34 m/s D) 23 m/s E) 11 m/s

140) Abby throws a ball straight up and times it. She sees that the ball goes by the top of a flagpole after 0.50 s and reaches the level of the top of the pole after a total elapsed time of 4.1 s. What was the speed of the ball at as it passed the top of the flagpole? Neglect air resistance. 140) _____

A) 16 m/s B) 29 m/s C) 18 m/s D) 6.4 m/s E) 33 m/s

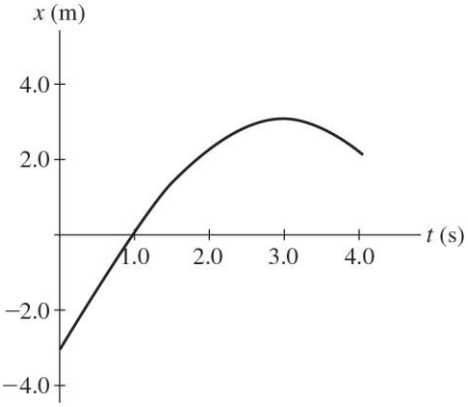
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

141) The graph in the figure represents the velocity of a particle as it travels along the x-axis. What is the average acceleration of the particle between t = 2.0 s and t = 4.0 s?



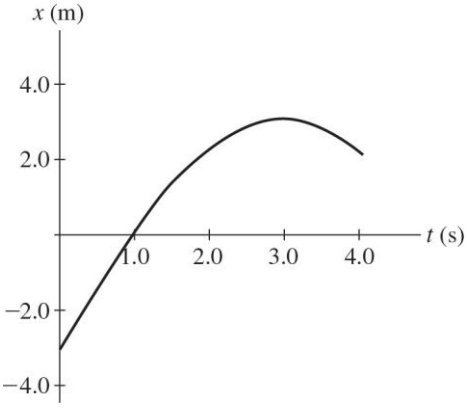
141) _____

142) The graph in the figure shows the position of a particle as a function of time as it travels along the x-axis.
(a) What is the average speed of the particle between t = 2.0 s and t = 4.0 s?
(b) What is the average velocity of the particle between t = 2.0 s and t = 4.0 s?



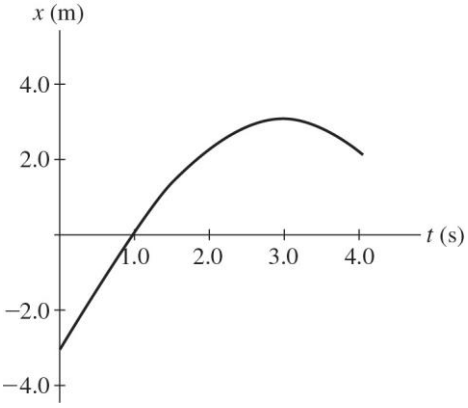
142) _____

143) The graph in the figure shows the position of a particle as a function of time as it travels along the x-axis.
(a) What is the magnitude of the average velocity of the particle between t = 1.0 s and t = 4.0 s?
(b) What is the average speed of the particle between t = 1.0 s and t = 4.0 s?



143) _____

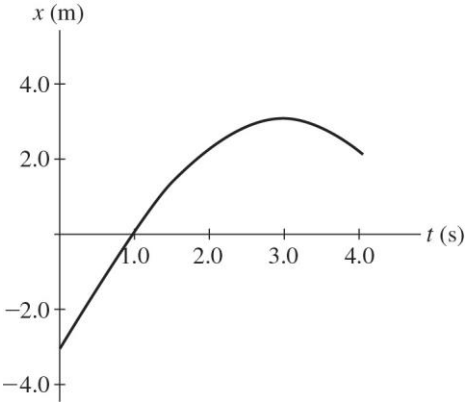
144) The graph in the figure shows the position of a particle as it travels along the x-axis. What is the magnitude of the instantaneous velocity of the particle when t = 1.0 s?



144) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

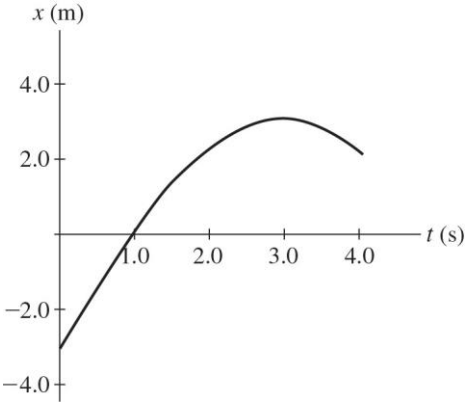
145) The graph in the figure shows the position of a particle as it travels along the x-axis. What is the magnitude of the average velocity of the particle between t = 1.0 s and t = 4.0 s?



145) _____

A) 1.3 m/s B) 1.0 m/s C) 0.67 m/s D) 0.25 m/s E) 0.50 m/s

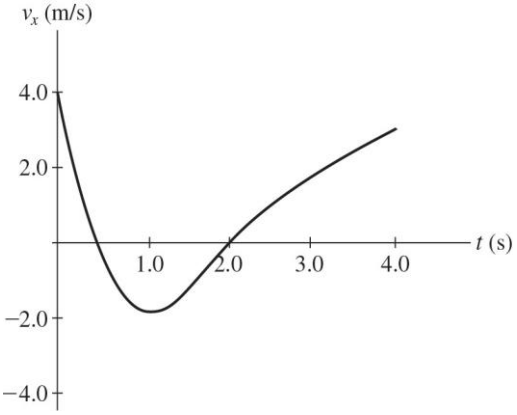
146) The graph in the figure shows the position of a particle as it travels along the x-axis. What is the magnitude of the average speed of the particle between t = 1.0 s and t = 4.0 s?



146) _____

A) 0.67 m/s B) 0.25 m/s C) 1.3 m/s D) 1.0 m/s E) 0.50 m/s

147) The graph in the figure shows the velocity of a particle as it travels along the x-axis. What is the magnitude of the average acceleration of the particle between t = 1.0 s and t = 4.0 s?

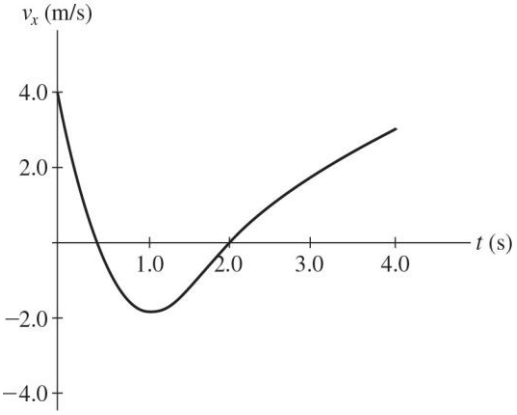


147) _____

A) 1.7 m/s^2 B) 2.5 m/s^2 C) 2.0 m/s^2 D) 3.0 m/s^2 E) 0.33 m/s^2

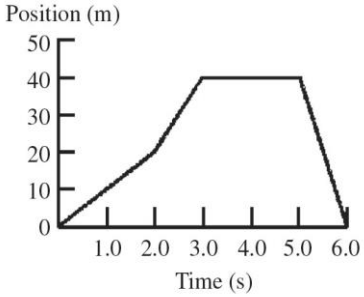
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

148) The graph in the figure shows the velocity of a particle as it travels along the x-axis. (a) In what direction (+x or -x) is the acceleration at t = 0.5 s?
(b) In what direction (+x or -x) is the acceleration at t = 3.0 s?
(c) What is the average acceleration of the particle between t = 2.0 s and t = 4.0 s?
(d) At what value of t is the instantaneous acceleration equal to 0 m/s^2?



148) _____

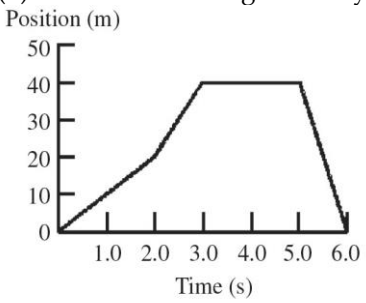
149) The figure shows a graph of the position of a moving object as a function of time. What is the velocity of the object at each of the following times?
(a) At t = 1.0 s
(b) At t = 2.5 s
(c) At t = 4.0 s
(d) At t = 5.5 s



149) _____

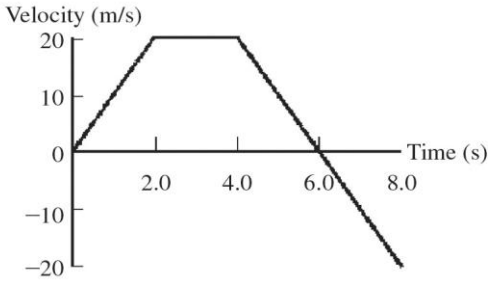
150) The figure shows a graph of the position of a moving object as a function of time.

(a) What is the average velocity of the object from t = 0 s to t = 4.0 s?
(b) What is the average velocity of the object from t = 0 s to t = 6.0 s?



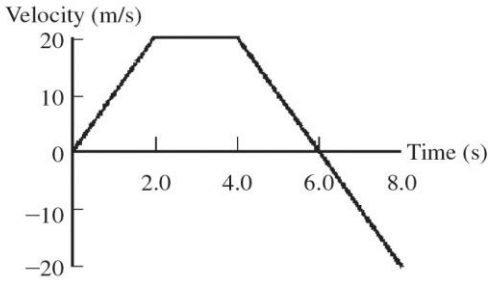
150) _____

151) The figure shows a graph of the velocity of an object as a function of time. What is the acceleration of the object at the following times?
(a) At 1.0 s
(b) At 3.0 s



151) _____

152) The figure shows a graph of the velocity of an object as a function of time. What is the average acceleration of the object over the following time intervals?
(a) From t = 0 s to t = 5.0 s
(b) From t = 0 s to t = 8.0 s



152) _____

153) A velocity vector has components 36 m/s westward and 22 m/s northward. What are the magnitude and direction of this vector? 153) _____

CLO2 Vectors

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

154) The x component of vector $\vec{A}$ is 8.7 units, and its y component is -6.5 units. The magnitude of $\vec{A}$ is closest to
154) _____

A) 9.9 units B) 8.9 units C) 7.9 units D) 12 units E) 11 units

155) When rolled down a mountainside at 7.0 m/s, the horizontal component of its velocity vector was 1.8 m/s. What was the angle of the mountain surface above the horizontal? 155) _____

A) 33° B) 75° C) 57 ° D) 15°

156) 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? 156) _____

A) 4.3 m/s B) 3.8 m/s C) 3.4 m/s D) 4.8 m/s

157) 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 157) _____

A) 250° B) 340° C) 23° D) 160° E) 110°

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

158) A vector in the xy-plane has an x component of -7.50 units. What must be the y component of this vector so that its magnitude is 10.0 units. (*Note:* There are *two* possible answers.) 158) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

159) A displacement vector is 34.0 m in length and is directed 60.0° east of north. Selecting from the choices in the table below, what are the components of this vector?

choice	Northward component	Eastward component
1	29.4 m	17.0 m
2	18.2 m	28.1 m
3	22.4 m	11.5 m
4	17.0 m	29.4 m
5	25.2 m	18.2 m

159) _____

A) choice 1 B) choice 2 C) choice 3 D) choice 4 E) choice 5

160) A player throws a football 50.0 m at 61.0° north of west. What is the westward component of the displacement of the football? 160) _____

A) 24.2 m B) 55.0 m C) 0.00 m D) 64.7m E) 74.0 m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

161) A vector $\vec{\mathbf{A}}$ has components A_x = 12.0 m and A_y = 5.00 m.

(a) What is the angle that vector $\vec{\mathbf{A}}$ makes with the +x-axis?

(b) What is the magnitude of vector $\vec{\mathbf{A}}$? 161) _____

162) The x and y components of a vector in a horizontal plane are 4.00 m and 3.00 m, respectively.

(a) What is the magnitude of this vector?

(b) What angle does this vector make with the positive +y-axis. 162) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

163) A boy jumps with a velocity of magnitude 20.0 m/s at an angle of 25.0° above the horizontal. What is the horizontal component of the boy's velocity? 163) _____

A) 15.6 m/s B) 12.6 m/s C) 18.1 m/s D) 9.33 m/s E) 8.45 m/s

164) The magnitude of $\vec{A}$ is 5.5 m, and this vector lies in the second quadrant and makes an angle of 34 ° with the +*y*-axis. The components of $\vec{A}$ are closest to: 164) _____

A) A_x = -3.1 m, A_y = 4.6 m.
B) A_x = -4.6 m, A_y = 3.1 m.
C) A_x = 3.1 m, A_y = -4.6 m.
D) A_x = 4.6 m, A_y = -3.1 m.
E) A_x = -4.6 m, A_y = -3.1 m.

165) The components of vectors $\vec{B}$ and $\vec{C}$ are given as follows:

B_x = -9.2 C_x = -4.5
B_y = -6.1 C_y = 4.3

The angle (less than 180°) between vectors $\vec{B}$ and $\vec{C}$ is closest to 165) _____

A) 10°. B) 170°. C) 84°. D) 77°. E) 103°.

166) A car travels 20 km west and then 20 km south. What is the magnitude of its displacement vector? 166) _____
A) 20 km B) 0 km C) 40 km D) 28 km

167) 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? 167) _____

A) 75 m B) 35 m C) 68 m D) 39 m

168) You walk 53 m to the north, then you turn 60° to your right and walk another $45\,\mathrm{m}$. Determine the direction of your displacement vector. Express your answer as an angle relative to east. 168) _____

A) 57° N of E B) 63° N of E C) 69° N of E D) 50° N of E

169) The components of vectors $\vec{A}$ and $\vec{B}$ are given as follows:
A_x = 7.6 B_x = -5.1
A_y = -9.2 B_y = -6.8
What is the magnitude of the vector difference $\vec{B} - \vec{A}$? 169) _____

A) 13 B) 170 C) 16 D) 3.5 E) 3.4

170) If vector $\vec{A}$ has components A_x = -3.0 lb and A_y = -4.0 lb, and vector $\vec{B}$ has components B_x = 3.0 lb and B_y = -8.0 lb, what is the magnitude of vector $\vec{C} = \vec{A} - \vec{B}$? 170) _____

A) 16 lb B) 13 lb C) 7.2 lb D) 140 lb

171) Vector $\vec{A}$ has magnitude 2 units and is directed to the north. Vector $\vec{B}$ has magnitude 5 units and is directed to the south. Calculate the magnitude and direction of $\vec{A} - \vec{B}$. 171) _____

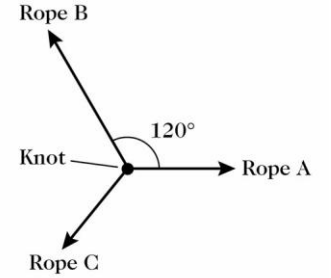
A) 3 units, south B) 3 units, north C) 7 units, south D) 7 units, north

172) Two perpendicular vectors, $\vec{A}$ and $\vec{B}$, are added together giving vector $\vec{C}$. If the magnitudes of both vectors $\vec{A}$ and $\vec{B}$ are doubled without changing their directions, the magnitude of vector $\vec{C}$ will 172) _____

A) increase by a factor of 4.
B) increase by a factor of $\sqrt{2}$.
C) increase by a factor of 8.
D) increase by a factor of 2.
E) not change.

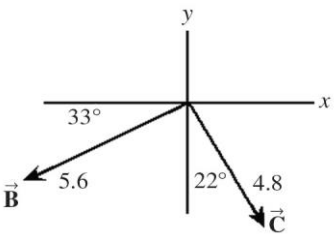
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

173) Three ropes are tied in a knot as shown in the figure. One student pulls on rope A with 1.0 pound of force, and another student pulls on rope B with 7.0 pounds of force. How *hard* and in what *direction* must you pull on rope C to *balance* the first two pulls? Give the direction by specifying the angle (clockwise or counterclockwise) of the pull with the direction of rope A.



173) _____

174) The figure shows two vectors $\vec{B}$ and $\vec{C}$, along with their magnitudes and directions. The vector $\vec{D}$ is given by $\vec{D} = \vec{B} - \vec{C}$.



(a) What is the magnitude of vector $\vec{D}$?

(b) What angle does vector $\vec{D}$ make with the +*x*-axis? 174) _____

175) Displacement vector $\vec{A}$ is 5.5 cm long and points along the +*x*-axis. Displacement vector $\vec{B}$ is 7.5 cm long and points at +30° to the -*x*-axis.

(a) Determine the x and y components of vector $\vec{A}$.

(b) Determine the x and y components of vector $\vec{B}$.

(c) Determine the x and y components of the resultant of these two vectors.

(d) Determine the magnitude and direction of the resultant of these two vectors.

175) _____

176) Displacement vector $\vec{A}$ is 75 cm long and points at 30° above the +x-axis. Displacement vector $\vec{B}$ is 25 cm long and points along the -x-axis. Displacement vector $\vec{C}$ is 40 cm long and points at 45° below the -x-axis.

(a) Determine the x and y components of vector $\vec{A}$.

(b) Determine the x and y components of vector $\vec{B}$.

(c) Determine the x and y components of vector $\vec{C}$.

(d) Determine the x and y components of the resultant of these three vectors.

(e) Determine the magnitude and direction of the resultant of these three vectors. 176) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

177) Vector $\vec{M}$ = 4.00 m points eastward and vector $\vec{N}$ = 3.00 m points southward. The resultant vector $\vec{M} + \vec{N}$ is given by 177) _____

A) 5.00 m at an angle of 26.6° south of east.
B) 5.00 m at an angle of 71.6° south of east.
C) 5.00 m at an angle of 36.9° south of east.
D) 5.00 m at an angle of 18.4° south of east.
E) 5.00 m at an angle of 53.1° south of east.

178) Vector $\vec{A}$ has a magnitude of 6.0 m and points 30° north of east. Vector $\vec{B}$ has a magnitude of 4.0 m and points 30° east of north. The resultant vector $\vec{A} + \vec{B}$ is given by 178) _____

A) 14 m at an angle of 42° north of east.
B) 1.1 m at an angle of 42° north of east.
C) 2.0 m at an angle of 42° north of east.
D) 0.70 m at an angle of 42° north of east.
E) 9.7 m at an angle of 42° north of east.

179) Vector $\vec{A}$ has a magnitude of 6.0 m and points 30° north of east. Vector $\vec{B}$ has a magnitude of 4.0 m and points 30° west of north. The resultant vector $\vec{A} + \vec{B}$ is given by 179) _____

A) 9.8 m at an angle of 26° north of east.
B) 3.3 m at an angle of 26° north of east.
C) 3.3 m at an angle of 64° east of north.
D) 9.8 m at an angle of 64° east of north.
E) 7.2 m at an angle of 26° east of north.

180) Vector $\vec{A}$ has a magnitude of 6.0 m and points 30° north of east. Vector $\vec{B}$ has a magnitude of 4.0 m and points

30° west of south. The resultant vector $\vec{A} + \vec{B}$ is given by 180) _____

A) 2.7 m at an angle of 8.3° east of south.
B) 3.2 m at an angle of 8.3° east of south.
C) 2.7 m at an angle of 8.3° south of east.
D) 3.2 m at an angle of 8.3° south of east.
E) 2.3 m at an angle of 8.3° south of east.

181) Vector $\vec{A}$ has a magnitude of 6.0 m and points 30° south of east. Vector $\vec{B}$ has a magnitude of 4.0 m and points 30° west of south. The resultant vector $\vec{A} + \vec{B}$ is given by 181) _____

A) 7.2 m at an angle of 64° south of east.
B) 9.8 m at an angle of 64° south of east.
C) 3.3 m at an angle of 64° south of east.
D) 3.3 m at an angle of 26° south of east.
E) 9.8 m at an angle of 26° south of east.

182) Vector $\vec{A}$ has a magnitude of 4.0 m and points 30° south of east. Vector $\vec{B}$ has a magnitude of 2.0 m and points 30° north of west. The resultant vector $\vec{A} + \vec{B}$ is given by 182) _____

A) 1.0 m at an angle 30° east of south.
B) 2.0 m at an angle 30° south of east.
C) 2.0 m at an angle 60° south of east.
D) 10.0 m at an angle 60° east of south.
E) 10.0 m at an angle 30° south of east.

183) Vector $\vec{A}$ has a magnitude of 7.0 m and points 30° east of north. Vector $\vec{B}$ has a magnitude of 5.0 m and points 30° west of south. The resultant vector $\vec{A} + \vec{B}$ is given by 183) _____

A) 10.0 m at an angle 30° east of north.
B) 2.0 m at an angle 60° north of east.
C) 2.0 m at an angle 30° north of east.
D) 1.0 m at an angle 60° east of north
E) 10.0 m at an angle 60° north of east.

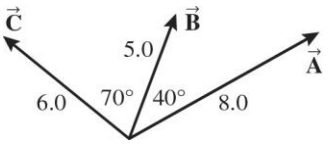
184) Vector $\vec{A}$ has a magnitude of 6.0 m and points 30° east of south. Vector $\vec{B}$ has a magnitude of 4.0 m and points 30° west of north. The resultant vector $\vec{A} + \vec{B}$ is given by 184) _____

A) 10.0 m at an angle of 60° north of west.
B) 2.0 m at an angle of 30° north of west.
C) 1.0 m at an angle of 60° north of west.
D) 2.0 m at an angle of 30° east of south.
E) 10.0 m at an angle of 60° east of south.

185) Vector $\vec{A}$ has a magnitude of 8.0 m and points east, vector $\vec{B}$ has a magnitude of 6.0 m and points north, and vector $\vec{C}$ has a magnitude of 5.0 m and points west. The resultant vector $\vec{A} + \vec{B} + \vec{C}$ is given by 185) _____

A) 3.8 m at an angle 67° north of east
B) 2.0 m at an angle 63° north of east.
C) 6.7 m at an angle 63° north of east.
D) 2.0 m at an angle 63° east of north.
E) 6.7 m at an angle 63° east of north.

186) The figure shows three vectors and their magnitudes and relative directions. The magnitude of the resultant of the three vectors is closest to

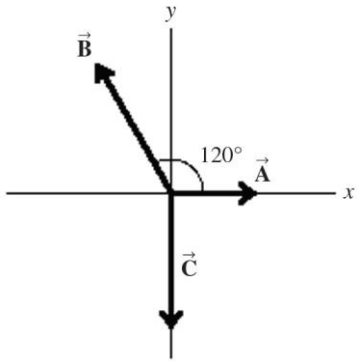


186) _____

A) 10 B) 7.0 C) 13 D) 16 E) 19

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

187) Find the magnitude and direction of the resultant of the three force vectors, $\vec{A}$, $\vec{B}$, and $\vec{C}$, shown in the figure. These vectors have the following magnitudes: A = 5.0 lb, B = 7.9 lb, and C = 8.0 lb. Express the direction of the resultant by specifying the angle it makes with the +x-axis, with counterclockwise angles taken to be positive.



187) _____

188) Two boys, Joe and Sam, who are searching for buried treasure start underneath the same tree. Joe walks 12 m east and then 12 m north, while Sam walks 15 m west and then 10 m south. Both boys then stop. Find the magnitude and direction of the vector from Sam to Joe. Express the direction of this vector by specifying the angle it makes with the west-to-east direction. 188) _____

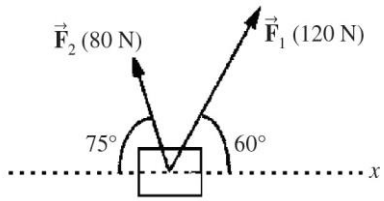
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

189) An airplane undergoes the following displacements, all at the same altitude: First, it flies 59.0 km in a direction 30.0° east of north. Next, it flies 58.0 km due south. Finally, it flies 100 km 30.0° north of west. Use components to determine how far the airplane ends up from its starting point. 189) _____

A) 70.1 km B) 74.4 km C) 71.5 km D) 73.0 km E) 68.7 km

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

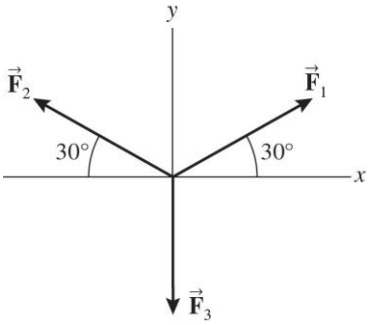
190) Two forces are acting on an object as shown in the figure. Assume that all the quantities shown are accurate to three significant figures.



(a) What is the magnitude of the resultant force on the object?
(b) What is the direction of the resultant force? 190) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

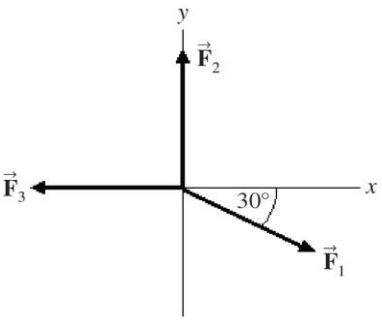
191) Three forces, $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$, each of magnitude 70 N, all act on an object as shown in the figure. The magnitude of the resultant force acting on the object is



191) _____

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

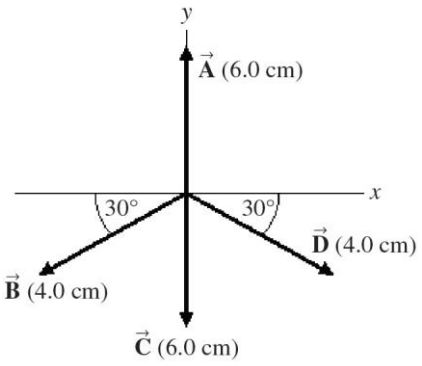
192) Three forces, $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$, all act on an object, as shown in the figure. The magnitudes of the forces are: F_1 = 80.0 N, F_2 = 60.0 N, and F_3 = 40.0 N. The resultant force acting on the object is given by



192) _____

A) 35.5 N at an angle of 34.3° with respect to +*x*-axis.
B) 180 N at an angle of 60.0° with respect to +*x*-axis.
C) 60.0 N at an angle of 90.0° with respect to +*x*-axis.
D) 40.0 N at an angle of 60.0° with respect to +*x*-axis.
E) 20.0 N at an angle of 34.3° with respect to +*x*-axis.

193) Four vectors, $\vec{A}$, $\vec{B}$, $\vec{C}$, and $\vec{D}$, are shown in the figure. The sum of these four vectors is a vector having magnitude and direction



193) _____

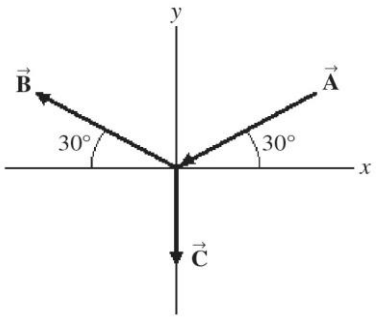
A) 4.0 cm, along +*y*-axis.
B) 4.0 cm, along -*y*-axis.
C) 4.0 cm, 45° above +*x*-axis.
D) 4.0 cm, along -*x*-axis.
E) 4.0 cm, along +*x*-axis.

194) Vector $\vec{A}$ has a magnitude of 8.0 m and points 30° north of east; vector $\vec{B}$ has a magnitude of 6.0 m and points 30° west of north; and vector $\vec{C}$ has a magnitude of 5.0 m and points 30° west of south. The resultant vector $\vec{A} + \vec{B} + \vec{C}$ is given by 194) _____

A) 5.9 m at an angle 74° north of east.
B) 2.1 m at an angle 66° east of north.
C) 5.1 m at an angle 74° north of east.
D) 2.7 m at an angle 74° north of east.
E) 4.8 m at an angle 74° east of north.

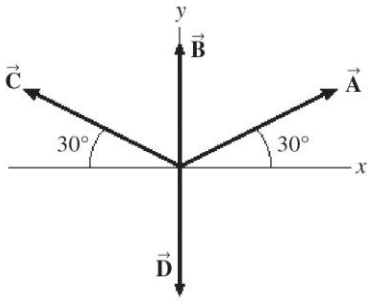
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

195) The figure shows three vectors, $\vec{A}$, $\vec{B}$, and $\vec{C}$, having magnitudes 7.0 cm, 6.0 cm, and 4.0 cm, respectively. Find the *x* and *y* components of the resultant of these three vectors.



195) _____

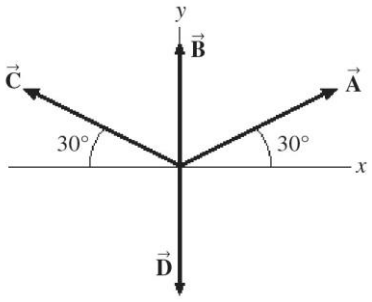
196) The figure shows four vectors, $\vec{A}$, $\vec{B}$, $\vec{C}$, and $\vec{D}$, having magnitudes 10.0 m, 8.00 m, 6.00 m, and 2.00 m, respectively. Find the magnitude of the sum of these four vectors.



196) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

197) The figure shows four vectors, $\vec{A}$, $\vec{B}$, $\vec{C}$, and $\vec{D}$, having magnitudes 12.0 m, 10.0 m, 8.0 m, and 4.0 m, respectively. The sum of these four vectors is

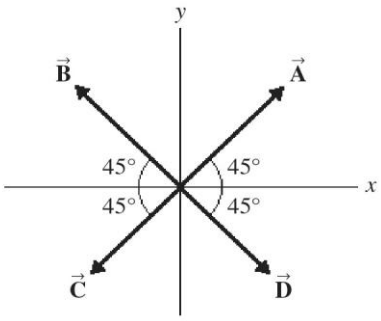


197) _____

A) 16.4 m at an angle 12.3° with respect to +*x*-axis.
B) 8.20 m at an angle 77.8° with respect to +*x*-axis.
C) 19.5 m at an angle 12.3° with respect to +*x*-axis.
D) 16.4 m at an angle 77.8° with respect to +*x*-axis.
E) 19.5 m at an angle 77.8° with respect to +*x*-axis.

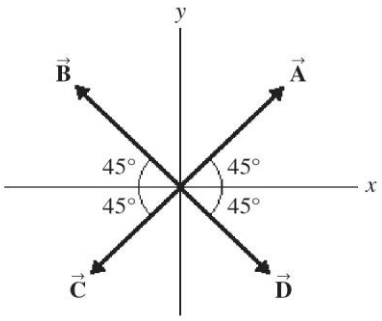
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

198) The figure shows four vectors, $\vec{A}$, $\vec{B}$, $\vec{C}$, and $\vec{D}$. Vectors $\vec{A}$ and $\vec{B}$ each have a magnitude of 7.0 cm, and vectors $\vec{C}$ and $\vec{D}$ each have a magnitude of 4.0 cm. Find the *x* and *y* components of the sum of these four vectors.



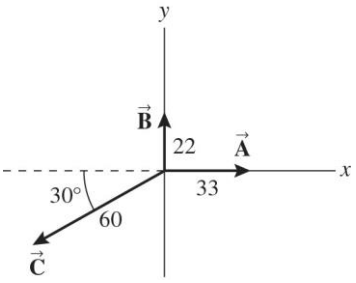
198) _____

199) The figure shows four vectors, $\vec{A}$, $\vec{B}$, $\vec{C}$, and $\vec{D}$. Vectors $\vec{A}$ and $\vec{B}$ both have a magnitude of 7.0 cm, and vectors $\vec{C}$ and $\vec{D}$ both have a magnitude of 4.0 cm. Find the magnitude and direction of the sum of these four vectors.



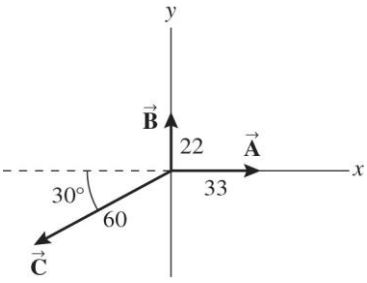
199) _____

200) The figure shows three vectors, $\vec{A}$, $\vec{B}$, and $\vec{C}$, along with their magnitudes. Determine the magnitude and direction of the vector given by $\vec{A} - \vec{B} - \vec{C}$.



200) _____

201) The figure shows three vectors, $\vec{A}$, $\vec{B}$, and $\vec{C}$, along with their magnitudes. Determine the magnitude and direction of the vector given by $\vec{A} + \vec{B} - \vec{C}$.



201) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

202) Three vectors, $\vec{S}$, $\vec{T}$, and $\vec{U}$, have the components shown in the table. What is the magnitude of the resultant of these three vectors?

	x component	*y* component
$\vec{S}$	3.50 m	-4.50 m
$\vec{T}$	2.00 m	0.00 m
$\vec{U}$	-5.50 m	2.50 m

202) _____

A) 13.0 m B) 2.00 m C) 11.1 m D) 5.50 m E) 7.00 m

203) Three vectors, $\vec{S}$, $\vec{T}$, and $\vec{U}$, have the components shown in the table. What angle does the resultant of these three

vectors make with the +*x*-axis?

	x component	*y* component
$\vec{S}$	-3.5 m	4.5 m
$\vec{T}$	0.00 m	-6.5 m
$\vec{U}$	5.5 m	-2.5 m

203) _____

A) 24° below the +*x*-axis B) 24° above the +*x*-axis
C) 66° below the +*x*-axis D) 66° above the +*x*-axis

CLO3 2-3D motion

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
204) A runner runs on a circular path of radius 10 m. What is the magnitude of the displacement of the jogger if he runs
(a) half-way around the track?
(b) all the way around the track?204) _____

205) A player hits a tennis ball into the air with an initial velocity of 32 m/s at 35° from the vertical. How fast is the ball moving at the highest point in its trajectory if air resistance is negligible? 205) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
206) A ball is thrown with an initial velocity of 20 m/s at an angle of 60° above the horizontal. If we can neglect air resistance, what is the horizontal component of its instantaneous velocity at the exact top of its trajectory? 206) _____

A) zero B) 17 m/s C) 10 m/s D) 20 m/s

207) A ball is thrown at an original speed of 8.0 m/s at an angle of 35° above the horizontal. If there is no air resistance, what is the speed of the ball when it returns to the same horizontal level? 207) _____

A) 4.0 m/s B) 9.8 m/s C) 16 m/s D) 8.0 m/s

208) 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? 208) _____

A) 22 m B) 91 m C) 43 m D) 77 m

209) A girl throws a rock horizontally, with a velocity of 10 m/s, from a bridge. It falls 20 m to the water below. How far does the rock travel horizontally before striking the water, assuming negligible air resistance? 209) _____

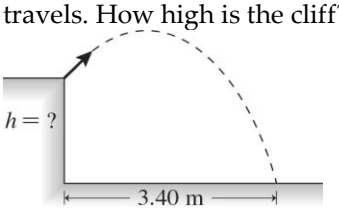
A) 24 m B) 16 m C) 14 m D) 20 m

210) A ball thrown horizontally from a point 24 m above the ground, strikes the ground after traveling horizontally a distance of 18 m. With what speed was it thrown, assuming negligible air resistance? 210) _____

A) 6.1 m/s B) 8.9 m/s C) 7.4 m/s D) 8.1 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
211) As shown in the figure, a heavy rock is shot upward from the edge of a vertical cliff. It leaves the edge of the cliff

with an initial velocity of 15 m/s directed at 25° from the vertical and experiences no appreciable air resistance as it travels. How high is the cliff?



211) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

212) The acceleration due to gravity on the Moon is only one-sixth of that on Earth, and the Moon has no atmosphere. If you hit a baseball on the Moon with the same effort (and therefore at the speed and angle) as on Earth, how far would the ball would travel on the Moon compared to on Earth? Neglect air resistance on Earth. 212) _____

A) 1/6 as far as on Earth
B) $\sqrt{6}$ as far as on Earth
C) the same distance as on Earth
D) 6 times as far as on Earth
E) 36 times as far as on Earth

213) A boy throws a rock with an initial velocity of $3.13\ \text{m/s}$ 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 $g = 9.80\ \text{m/s}^2$? 213) _____

A) 0.282 s B) 0.441 s C) 0.313 s D) 0.160 s

214) A cat leaps to try to catch a bird. If the cat's jump was at 60° off the ground and its initial velocity was $2.74\ \text{m/s}$ what is the highest point of its trajectory, neglecting air resistance? 214) _____

A) 0.29 m B) 10.96 m C) 0.58 m D) 0.19 m

215) A fisherman casts his bait toward the river at an angle of 25° above the horizontal. As the line unravels, he notices that the bait and hook reach a maximum height of $2.9\,\text{m}$. What was the initial velocity he launched the bait with? Assume that the line exerts no appreciable drag force on the bait and hook and that air resistance is negligible. 215) _____

A) 7.9 m/s B) 7.6 m/s C) 6.3 m/s D) 18 m/s

216) A football kicker is attempting a field goal from $44\,\text{m}$ out. The ball is kicked and just clears the lower bar with a time of flight of $2.9\,\text{s}$. If the angle of the kick was 45°, what was the initial speed of the ball, assuming no air resistance? 216) _____

A) 21.5 m/s B) 2.2 m/s C) 39 m/s D) 19.7 m/s

217) You throw a rock horizontally off a cliff with a speed of 20 m/s and no significant air resistance. After 2.0 s, the magnitude of the velocity of the rock is closest to217) _____

A) 37 m/s B) 20 m/s C) 28 m/s D) 40 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

218) A shell is launched with a velocity of 100 m/s at an angle of 30.0° above horizontal from a point on a cliff 50.0 m above a level plain below. How far from the base of the cliff does the shell strike the ground? There is no appreciable air resistance, and $g = 9.80\ \text{m/s}^2$ at the location of the cliff. 218) _____

219) At target practice, a rifle bullet is fired at an angle of 30° below the horizontal with an initial velocity of 800 m/s from the top of a cliff 80 m high. How far from the base of the cliff does it strike the level ground below if air resistance is negligible? 219) _____

220) A batter hits a home run in which the ball travels 110 m horizontally with no appreciable air resistance. If the ball left the bat at 50° above the horizontal just above ground level, how fast was it hit? 220) _____

221) A marble moving 1.48 m/s rolls off the top edge of a 125-cm high table in a room where there is no appreciable air resistance and the acceleration due to gravity is 9.80 m/s^2.
(a) How far from the base of the table will it strike the floor?
(b) How long will it be in the air? 221) _____

222) A hunter points a rifle horizontally and holds it 3.30 m above the ground. The bullet leaves the barrel at 325 m/s and experiences no significant air resistance. The acceleration due to gravity at this location is 9.80 m/s^2.
(a) How long does it take for the bullet to strike the ground?
(b) How far horizontally does it travel? 222) _____

223) A girl throws a rock horizontally with a speed of 12 m/s from a bridge. It falls 2.28 s before hitting the water below. Neglect air resistance.
(a) How high is the bridge from the water below?
(b) How far horizontally does the rock travel before striking the water? 223) _____

224) A celebrating student throws a water balloon horizontally from a dormitory window that is 50 m above the ground. It hits the ground at a point 60 m from the building without appreciable air resistance.
(a) What will be the horizontal component of the velocity of the balloon just before it hits the ground?
(b) What will be the magnitude of the vertical velocity of the balloon just before it hits the ground? 224) _____

225) Enzo throws a rock horizontally with a speed of 12 m/s from a bridge. It falls for 2.28 s before reaching the water below with no appreciable air resistance. Just as the rock reaches the water, find
(a) the horizontal component of its velocity.
(b) the speed with which it is moving. 225) _____

226) A ball rolls over the edge of a platform with a horizontal velocity of magnitude v. The height of the platform is 1.6 m and the horizontal range of the ball from the base of the platform is 20 m. What is the magnitude of v if air resistance is negligibly small? 226) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
227) A hockey puck slides off the edge of a platform with an initial velocity of 20 m/s horizontally. The height of the platform above the ground is 2.0 m. What is the magnitude of the velocity of the puck just before it touches the ground? You can neglect air resistance. 227) _____

A) 24 m/s B) 6.3 m/s C) 21 m/s D) 22 m/s E) 25 m/s

228) A hockey puck slides off the edge of a horizontal platform with an initial velocity of 20 m/s horizontally and

experiences no significant air resistance. The height of the platform above the ground is 2.0 m. What is the magnitude of the vertical component of the velocity of the puck just before it hits the ground? 228) _____

A) 20 m/s B) 21 m/s C) 13 m/s D) 6.3 m/s E) 15 m/s

229) A hockey puck slides off the edge of a horizontal platform with an initial velocity of 28.0 m/shorizontally in a city where the acceleration due to gravity is 9.81 m/s^2. The puck experiences no significant air resistance as it falls. The height of the platform above the ground is 2.00 m. What is the angle below the horizontal of the velocity of the puck just before it hits the ground? 229) _____

A) 12.6° B) 31.8° C) 12.8° D) 72.6° E) 77.2°

230) A plane flying horizontally at a speed of 50 m/s and at an elevation of 160 m drops a package, and 2.0 s later it drops a second package. How far apart will the two packages land on the ground if air resistance is negligible? 230) _____

A) 180 m B) 100 m C) 320 m D) 160 m

231) In a room where g = 9.81 m/s^2, a hockey puck slides off the edge of a platform with an initial velocity of 28.0 m/s horizontally. The height of the platform above the ground is 2.00 m. What is the speed of the puck just before it hits the ground? The air resistance is negligibly small. 231) _____

A) 28.7 m/s B) 6.26 m/s C) 48.2 m/s D) 28.0 m/s E) 26.3 m/s

232) A ball rolls over the edge of a platform with only a horizontal velocity. The height of the platform is 1.6 m and the horizontal range of the ball from the base of the platform is 20 m. What is the horizontal velocity of the ball just before it touches the ground? Neglect air resistance. 232) _____

A) 9.8 m/s B) 20 m/s C) 70 m/s D) 35 m/s E) 4.9 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

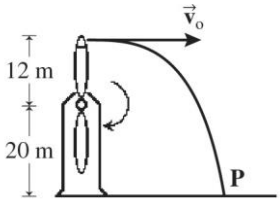
233) A projectile is shot horizontally at 23.4 m/s from the roof of a building 55 m tall and experiences negligible air resistance.
(a) Determine the time necessary for the projectile to reach the ground below.
(b) Determine the distance from the base of the building that the projectile lands.
(c) Determine the horizontal and vertical components of the velocity just before the projectile reaches the ground. 233) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

234) A person throws a ball horizontally from the top of a building that is 24.0 m above the ground level. The ball lands 100 m down range from the base of the building. What was the initial velocity of the ball? Neglect air resistance and use g = 9.81 m/s^2. 234) _____

A) 9.80 m/s B) 45.2 m/s C) 202 m/s D) 94.4° E) 19.6 m/s

235) A wind farm generator uses a two-bladed propeller mounted on a pylon at a height of 20 m, as shown in the figure. The width of the pylon is very narrow, and the length of each propeller blade is 12 m. A tip of the propeller breaks off just when the propeller is vertical. The fragment flies off horizontally, falls, and strikes the ground at point P with negligible air resistance. Just before the fragment broke off, the propeller was turning uniformly, taking 1.2 s for each rotation. How far is point P from the base of the pylon?



235) _____

A) 150 m B) 160 m C) 140 m D) 130 m E) 120 m

236) 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? 236) _____

A) 25 m B) 50 m C) 43 m D) 5.4 m E) 13 m

237) A projectile is fired from ground level with a speed of 150 m/s at an angle 30° above the horizontal on an airless planet where g = 10.0 m/s^2. What is the horizontal component of its velocity after 4.0 s? 237) _____

A) 38 m/s B) 35 m/s C) 75 m/s D) 130 m/s E) 150 m/s

238) A high-speed dart is shot from ground level with a speed of 150 m/s at an angle 30° above the horizontal. What is the vertical component of its velocity after 4.0 s if air resistance is neglected? 238) _____

A) 36 m/s B) 75 m/s C) 38 m/s D) 150 m/s E) 130 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

239) A projectile leaves the ground at 150 m/s and reaches a maximum height of 0.57 km. If there was no air resistance, at what angle above the horizontal did it leave the ground? 239) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

240) A child is trying to throw a ball over a fence. She gives the ball an initial speed of 8.0 m/s at an angle of 40° above the horizontal. The ball leaves her hand 1.0 m above the ground and the fence is 2.0 m high. The ball just clears the fence while still traveling upwards and experiences no significant air resistance. How far is the child from the fence? 240) _____

A) 3.8 m B) 2.7 m C) 1.6 m D) 7.5 m E) 0.73 m

241) A boy kicks a football from ground level with an initial velocity of 20 m/s at an angle of 30° above the horizontal. What is the horizontal distance to the point where the football hits the ground if we neglect air resistance? 241) _____

A) 20 m B) 60 m C) 18 m D) 30.0 m E) 35 m

242) 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? 242) _____

A) 4.0 m B) 8.0 m C) 17 m D) 12 m E) 0.88 m

243) 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? 243) _____

A) 0.54 s B) 0.50 s C) 0.88 s D) 2.5 s E) 1.1 s

244) An athlete participates in an interplanetary discus throw competition during an Olympiad that takes place on a

planet where the acceleration due to gravity is 9.7 m/s^2. He throws the discus with an initial velocity of 20 m/s at an angle of 60° from the vertical. Neglecting air resistance and the height of the discus at the point of release, what is the range of the discus? 244) _____

A) 32 m B) 21 m C) 40 m D) 60 m E) 36 m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

245) A child throws a ball with an initial speed of 8.0 m/s at an angle of 40° above the horizontal. The ball leaves her hand 1.0 m above the ground and experiences no appreciable air resistance as it moves.
(a) How far from where the child is standing does the ball hit the ground?
(b) How long is the ball in flight before it hits the ground?
(c) What is the magnitude of the ball's velocity just before it hits the ground? 245) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

246) A child throws a ball with an initial speed of 8.0 m/s at an angle of 40° above the horizontal. The ball leaves her hand 1.0 m above the ground. At what angle below the horizontal does the ball approach the ground? 246) _____

A) 40° B) 42° C) 65° D) 48° E) 35°

247) The horizontal and vertical components of the initial velocity of a football are 16 m/s and 20 m/s respectively. If there is no air resistance, how long does it take the football to reach the top of its trajectory? 247) _____

A) 5.0 s B) 4.0 s C) 1.0 s D) 2.0 s E) 3.0 s

248) A projectile is fired at an angle above the horizontal at a location where g = 9.8 m/s^2. The initial x and y components of its velocity are 86.6 m/s and 50 m/s respectively. At what angle was the projectile fired above the horizontal? 248) _____

A) 75° B) 30° C) 90° D) 45° E) 60°

249) A projectile is fired from ground level at an angle above the horizontal on an airless planet where g = 10.0 m/s^2. The initial x and y components of its velocity are 86.6 m/s and 50.0 m/s respectively. How long after firing does it take before the projectile hits the level ground? 249) _____

A) 20.0 seconds B) 5.00 seconds C) 15.0 seconds D) 10.0 seconds

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

250) A projectile is fired from ground level with an initial speed of 55.6 m/s at an angle of 41.2° above the horizontal. Neglect air resistance, take upward as the positive direction, and use g = 9.8 m/s^2.
(a) Determine the time necessary for the projectile to reach its maximum height.
(b) Determine the maximum height reached by the projectile.
(c) Determine the horizontal and vertical components of the velocity vector at the maximum height.
(d) Determine the horizontal and vertical components of the acceleration vector at the maximum height. 250) _____

251) At a location where g = 9.80 m/s^2, a projectile returns to its original height after 4.08 seconds, during which time it travels 76.2 meters horizontally. If air resistance can be neglected, what was the projectile's initial speed? 251) _____

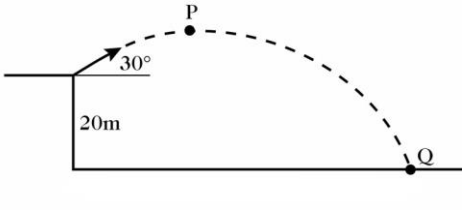
252) A rock is thrown from the roof of a building, with an initial velocity of 10 m/s at an angle of 30° above the horizontal. The rock is observed to strike the ground 43 m from the base of the building. What is the height of the building assuming

no air resistance? 252) _____

253) A 5.0-kg stone is thrown upward at 7.5 m/s at an angle of 51° above the horizontal from the upper edge of a cliff, and it hits the ground 1.5 s later with no air resistance. Find the magnitude of its velocity vector just as it reaches the ground.
253) _____

254) A projectile is thrown upward at 24° with the vertical and returns to the horizontal ground 12.5 s later with no air drag.
(a) How fast was it thrown?
(b) How far from its original position did it land?
(c) How high above its original position did it go? 254) _____

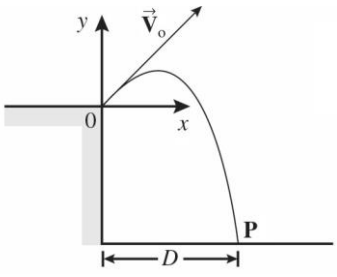
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
255) A projectile is fired from the edge of a cliff as shown in the figure. The initial velocity components are 940 m/s (horizontal) and 96 m/s (vertical). The projectile reaches maximum height at point P and then falls and strikes the ground at point Q. How high is point P above point Q, assuming no air resistance?



255) _____

A) 490 m B) 940 m C) 45,000 m D) 470 m E) 90,000 m

256) As shown in the figure, a projectile is fired at time $t = 0.00$ s, from point 0 at the upper edge of a cliff, with initial velocity components of $v_{0x} = 30\ \text{m/s}$ and $v_{0y} = 300\ \text{m/s}$. The projectile rises and then falls into the sea at point P. The time of flight of the projectile is $75.0\ \text{s}$, and air resistance is negligible. At this location, $g = 9.80\ \text{m/s}^2$. What is the horizontal distance D?



256) _____

A) 2790 m B) 3330 m C) 2520 m D) 2250 m E) 3060 m

257) A projectile is launched with an initial velocity of 80 m/s at 30° above the horizontal. Neglecting air resistance, what is horizontal component of the projectile's acceleration? 257) _____

A) 69 m/s^2 B) 80 m/s^2 C) 40 m/s^2 D) 0 m/s^2 E) 9.8 m/s^2

258) A boy kicks a football with an initial velocity of 20 m/s at an angle of 25° above the horizontal. If we neglect air resistance, the magnitude of the acceleration of the ball while it is in flight is 258) _____

A) 9.8 m/s^2. B) 18 m/s^2. C) 8.5 m/s^2. D) 0 m/s^2. E) 25 m/s^2.

259) A projectile is fired from ground level on a horizontal plain. If the initial speed of the projectile is now doubled, and we neglect air resistance, 259) _____

A) its range will be decreased by a factor of two.
B) its range will quadruple.
C) its range will double.
D) its range will decrease by a factor of four.
E) its range will be increased by $\sqrt{2}$.

260) A hobbyist launches a projectile from ground level on a horizontal plain. It reaches a maximum height of 72.3 m and lands 111 m from the launch point, with no appreciable air resistance. What was the angle of launch if $g = 9.80$ m/s^2? 260) _____

A) 69.0° B) 44.8° C) 67.4° D) 22.6°

261) You are traveling at 55 mi/h along the +*x*-axis relative to a straight, level road and pass a car that is traveling at 45 mi/h. The relative velocity of your car to the other car is261) _____

A) 65 mi/h. B) 35 mi/h. C) -10 mi/h. D) 10 mi/h.

262) Your motorboat can move at 30 km/h in still water. What is the *minimum* time it will take you to move 12 km downstream in a river flowing at 6.0 km/h? 262) _____

A) 30 min B) 24 min C) 20 min D) 22 min

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
263) An airplane with an airspeed of 140 km/h has a heading of 50° west of north in a wind that is blowing toward the east at 25 km/h. What is the groundspeed of the plane? 263) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
264) A plane has an airspeed of 200 m/s northward, and is in a wind of 50.0 m/s to the west. The plane's speed relative to the ground is 264) _____

A) 250 m/s. B) 206 m/s. C) 150 m/s. D) 200 m/s.

265) An airplane with an airspeed of 120 km/h has a heading of 30° east of north in a wind that is blowing toward the west at 30 km/h. What is the speed of the plane relative to the ground? 265) _____

A) 140 km/h B) 90 km/h C) 150 km/h D) 110 km/h

266) A plane moving 200 m/s horizontally fires a projectile with speed 50 m/s in a forward direction 30.0° below the horizontal. At that instant, what is the speed of the projectile with respect to a stationary observer on the ground? 266) _____

A) 250 m/s B) 268 m/s C) 245 m/s D) 293 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
267) Alicia intends to swim to a point straight across a 100 m wide river with a current that flows at 1.2 m/s. She can swim 2.5 m/s in still water. At what angle, measured from the upstream direction, must she swim upstream to achieve her goal? 267) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

268) On a calm day with no wind, you can run a 1500-m race at a velocity of 4.0 m/s. If you run the same race on a day when you have a constant headwind that slows your speed by 2.0 m/s, how much time would it take you to finish the race? 268) _____

A) 9000 s B) 750 s C) 1125 s D) 250 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

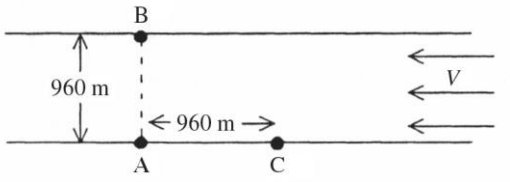
269) A pickup truck moves at 25 m/s toward the east. Ahmed is standing in the back and throws a baseball in what to him is the southwest direction at 28 m/s (with respect to the truck). A person at rest on the ground would see the ball moving how *fast* in what *direction*? 269) _____

270) A submarine must travel how *fast* (with respect to the water) and be pointed in what *direction* such that it moves 10 m/s directly northward (relative to the earth) if the water moves westward at 5.0 m/s? 270) _____

271) An airplane is pointed at 45° north of east and is moving at 71 m/s with respect to the air. The jet stream (moving air) carries the plane at 30 m/s toward the east. What are the magnitude and direction of the velocity of the plane relative to the ground? 271) _____

272) The driver of a motorboat that can move at 10 m/s in still water wishes to travel directly across a river in which the current flows at 5.0 m/s.
(a) At what angle, measured from the upstream direction, should the driver head the boat?
(b) How many minutes will it take to cross the river if it is 1.6 km wide at that point? 272) _____

273) A 960-m wide river flows at 16 m/s as shown in the figure. Alice and John have a race in identical boats which each travel 20 m/s in still water. Alice leaves point A and steers so that she goes straight to point B directly across and then back to A. John leaves point A and steers up to point C (960 m upstream) and then returns to A.
(a) Which person arrives back at point A first?
(b) How much *sooner* than the loser does the winner arrive back at point A?



273) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

274) A plane has an eastward heading with an airspeed of 156 m/s. A 20.0 m/s wind is blowing southward at the same time as the plane is flying. The velocity of the plane relative to the ground is 274) _____

A) 157 m/s at an angle 7.31° south of east.
B) 157 m/s at an angle 7.36° south of east.
C) 157 m/s at an angle 7.31° east of south.
D) 155 m/s at an angle 7.36° east of south.
E) 155 m/s at an angle 7.36° south of east.

275) A plane has an airspeed of 142 m/s. A 30.0 m/s wind is blowing southward at the same time as the plane is flying. What must be the heading of the plane in order to move directly eastward relative to the ground? 275) _____

A) 55.3° north of east
B) 78.1° north of east
C) 77.8° north of east
D) 11.9° north of east
E) 12.2° north of east

276) A plane has an airspeed of 142 m/s. A 16 m/s wind is blowing southward at the same time as the plane is flying. If the velocity of the plane relative to the ground is directly eastward, what is the magnitude of that velocity? 276) _____

A) 16 m/s B) 160 m/s C) 48 m/s D) 141 m/s E) 130 m/s

277) An airplane flies between two points on the ground that are 500 km apart. The destination is directly north of the point of origin of the flight. The plane flies with an airspeed of 120 m/s. If a constant wind blows at 10 m/s toward the west during the flight, what direction must the plane fly relative to the air to arrive at the destination? 277) _____

A) 4.8° west of north
B) 4.8° east of north
C) 5.9° east of north
D) 85° west of north
E) 5.9° west of north

278) A swimmer heading directly across a river that is 200 m wide reaches the opposite bank in 6 min 40 s. During this swim, she is swept downstream 480 m. How fast can she swim in still water? 278) _____

A) 0.80 m/s B) 0.50 m/s C) 1.8 m/s D) 1.4 m/s E) 1.2 m/s

279) A swimmer heading directly across a river that is 200 m wide reaches the opposite bank in 6 min 40 s. During this swim, she is swept downstream 480 m. What is the speed of the current? 279) _____

A) 0.80 m/s B) 1.2 m/s C) 1.8 m/s D) 1.4 m/s E) 0.50 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
280) A boat, whose speed in still water is 1.75 m/s, must aim upstream at an angle of 26.3° (with respect to a line perpendicular to the shore) in order to travel directly across the stream.
(a) What is the speed of the current?
(b) What is the resultant speed of the boat with respect to the shore? 280) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
281) A boat, whose speed in still water is 8.0 m/s, crosses a river with a current of 6.0 m/s. If the boat heads perpendicular to the current, what is the speed of the boat relative to an observer standing on the shore as it crosses the river? 281) _____

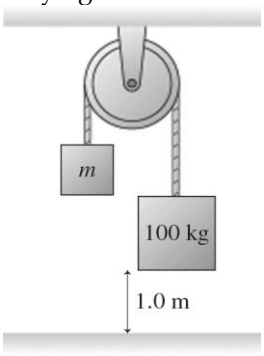
A) 6.0 m/s B) 5.3 m/s C) 8.0 m/s D) 10.0 m/s

282) A plane flies directly from city A to city B, which are separated by 2300 mi. From A to B, the plane flies into a 65 mi/h headwind. On the return trip from B to A, the wind velocity is unchanged. The trip from B to A takes $65\,\text{min}$ less than the trip from A to B. What is the airspeed (assumed constant) of the plane relative to the air (that is, the airspeed)? 282) _____

A) 480 mi/h B) 400 mi/h C) 530 mi/h D) 610 mi/h

283) The figure shows a 100-kg block being released from rest from a height of 1.0 m. It then takes 0.53 s for it to reach the floor. What is the mass *m* of the block on the left? There is no friction or mass in the pulley, and the connecting rope is

very light.



283) _____

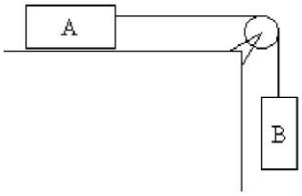
A) 11 kg B) 13 kgC) 16 kg D) 14 kg

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

284) A locomotive is pulling three train cars along a level track with a force of 100,000 N. The car next to the locomotive has a mass of 80,000 kg, the next one, 50,000 kg, and the last one, 70,000 kg. You can neglect the friction on the cars being pulled.
(a) What is the magnitude of the force between that the 80,000-kg car exerts on the 50,000-kg car?
(b) What is the magnitude of the force that the 50,000-kg car exerts on the 70,000-kg car? 284) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

285) In the figure, block A has a mass of 3.00 kg. It rests on a smooth horizontal table and is connected by a very light horizontal string over an ideal pulley to block B, which has a mass of 2.00 kg. When block B is gently released from rest, how long does it take block B to travel 80.0 cm?



285) _____

A) 0.935 s B) 0.639 s C) 0.785 s D) 0.494 s E) 0.404 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

286) A 55-kg box rests on a horizontal surface. The coefficient of static friction between the box and the surface is 0.30, and the coefficient of kinetic friction is 0.20. What horizontal force must be applied to the box to cause it to start sliding along the surface? 286) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

287) The coefficients of static and kinetic friction between a 3.0-kg box and a horizontal desktop are 0.40 and 0.30, respectively. What is the force of friction on the box when a 15-N horizontal push is applied to the box? 287) _____

A) 4.5 N B) 15 N C) 12 N D) 8.8 N E) 6.0 N

288) An object slides on a level floor. It slows and comes to a stop with a constant acceleration of magnitude 2.4 m/s^2. What is the coefficient of kinetic friction between the object and the floor? 288) _____

A) 0.48
B) 0.12
C) 0.24
D) It is impossible to determine without knowing the mass of the object.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

289) A bulldozer attempts to drag a log weighing 500 N along the rough horizontal ground. The cable attached to the log makes an angle of 30° above the ground. The coefficient of static friction between the log and the ground is 0.50, and the coefficient of kinetic friction is 0.35. What minimum tension is required in the cable in order for the log to begin to slide?

289) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

290) A policeman investigating an accident measures the skid marks left by a car on the horizontal road. He determines that the distance between the point that the driver slammed on the brakes (thereby locking the wheels) and the point where the car came to a stop was 28.0 m. From a reference manual he determines that the coefficient of kinetic friction between the tires and the road under the prevailing conditions was 0.300. How fast was the car going when the driver applied the brakes? 290) _____

A) 10.7 m/s B) 12.8 m/s C) 45.7 m/s D) 32.9 m/s E) 21.4 m/s

291) A 50-kg box is being pushed along a horizontal surface. The coefficient of static friction between the box and the ground is 0.65, and the coefficient of kinetic friction is 0.35. What horizontal force must be exerted on the box for it to accelerate at 1.2 m/s^2? 291) _____

A) 60 N B) 490 N C) 120 N D) 230 N E) 170 N

292) 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? 292) _____

A) 200 N B) 220 N C) 620 N D) 250 N E) 32 N

293) A baseball player is running to second base at 5.03 m/s. When he is 4.80 m from the plate he goes into a slide. The coefficient of kinetic friction between the player and the ground is 0.180, and the coefficient of static friction is 3.14. What is his speed when he reaches the plate? 293) _____

A) 2.89 m/s
B) 2.56 m/s
C) 1.96 m/s
D) 4.47 m/s
E) He stops before reaching the plate.

CLO4 Newton

294) 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?

294) _____

A) 72.7 kg B) 71.3 kg C) 69.9 kg D) 68.5 kg

295) If I weigh 741 N on Earth at a place where g = 9.80 m/s^2 and 5320 N on the surface of another planet, what is the acceleration due to gravity on that planet? 295) _____

A) 81.0 m/s^2 B) 70.4 m/s^2 C) 61.2 m/s^2 D) 51.4 m/s^2

296) 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? 296) _____

A) 16 N B) 440 N C) 99 N D) 61 N E) 600 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

297) An object has a mass of 60 kg on Earth. What are the mass and weight of this object on the surface of the Moon where the acceleration due to gravity is only 1/6 of what it is on Earth? 297) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

298) A net force of 125 N is applied to a certain object. As a result, the object accelerates with an acceleration of 24.0 m/s^2. The mass of the object is 298) _____

A) 5.21 kg. B) 3000 kg. C) 0.200 kg. D) 2880 kg. E) 144 kg.

299) If a net force accelerates a 4.5-kg tool at 40 m/s^2, what acceleration would that same net force give to an 18-kg tool? 299) _____

A) 32 m/s^2 B) 160 m/s^2 C) 180 m/s^2 D) 9.8 m/s^2 E) 10 m/s^2

300) A block is on a frictionless table, on earth. The block accelerates at 3.0 m/s^2 when a $20\,N$ horizontal force is applied to it. The block and table are set up on the Moon where the acceleration due to gravity is 1.62 m/s^2. The weight of the block on the Moon is closest to 300) _____

A) 9.5 N. B) 6.8 N. C) 11 N. D) 8.1 N. E) 5.5 N.

301) A block is on a frictionless table, on earth. The block accelerates at 5.3 m/s^2 when a $10\,N$ horizontal force is applied to it. The block and table are set up on the Moon where the acceleration due to gravity is 1.62 m/s^2. A horizontal force of 5 N is now applied to the block when it is on the Moon. The acceleration imparted to the block by this force is closest to 301) _____

A) 3.2 m/s^2. B) 3.4 m/s^2. C) 2.7 m/s^2. D) 2.9 m/s^2. E) 2.4 m/s^2.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

302) A 40-kg crate is being lowered with a downward acceleration is 2.0 m/s^2 by means of a rope.
(a) What is the magnitude of the force exerted by the rope on the crate?
(b) What would be the magnitude of the force exerted by the rope if the crate were being raised with an acceleration of 2.0 m/s^2? 302) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

303) A 450-kg sports car accelerates from rest to 100 km/h in 4.80 s. What magnitude force does a 68.0 kg passenger experience during the acceleration? 303) _____

A) 342 N B) 82.0 N C) 311 N D) 394 N

304) On its own, a tow truck has a maximum acceleration of 3.0 m/s^2. What will be its maximum acceleration when the truck is using a light horizontal chain to tow a bus of twice its own mass? 304) _____

A) 2.0 m/s^2 B) 1.0 m/s^2 C) 1.5 m/s^2 D) 2.5 m/s^2

305) A car of mass 1100 kg that is traveling at 27 m/s starts to slow down and comes to a complete stop in 578 m. What is the magnitude of the average braking force acting on the car? 305) _____

A) 340 N B) 410 N C) 550 N D) 690 N

306) A certain aircraft has a mass of 300,000 kg. At a certain instant during its landing, its speed is 27.0 m/s. If the braking force is a constant 445,000 N, what is the speed of the airplane 10.0 s later? 306) _____

A) 20.0 m/s B) 10.0 m/s C) 18.0 m/s D) 12.2 m/s E) 14.0 m/s

307) 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? 307) _____

A) 4360 N B) 444 N C) 11800 N D) 1620 N E) 3240 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

308) A catcher stops a 0.15-kg ball traveling at 40 m/s in a distance of 20 cm. What is the magnitude of the average force that the ball exerts against his glove? 308) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

309) An object that weighs 75 N is pulled on a horizontal surface by a horizontal pull of 50 N to the right. The friction force on this object is 30 N to the left. What is the acceleration of the object? 309) _____

A) 1.1 m/s^2 B) 11 m/s^2 C) 0.27 m/s^2 D) 2.6 m/s^2

310) A 1200-kg car is pulling a 500-kg trailer along level ground. Friction of the road on the trailer is negligible. The car accelerates with an acceleration of 1.3 m/s^2. What is the force exerted by the car on the trailer? 310) _____

A) 750 N B) 550 N C) 650 N D) 700 N E) 600 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

311) In a certain particle accelerator, a proton reaches an acceleration of 9.0×10^{13} m/s^2. The mass of a proton is 1.67×10^{-27} kg. What is the force on the proton? 311) _____

312) During a hard stop, a car and its passengers slow down with an acceleration of 8.0 m/s^2. What magnitude force does a 50-kg passenger exert on the seat belt in such a stop? 312) _____

313) A flatbed truck is carrying an 800-kg load of timber that is not tied down. The maximum friction force between the truck bed and the load is 2400 N. What is the greatest acceleration that the truck can have without losing its load? 313) _____

314) A box of mass 72 kg is at rest on a horizontal frictionless surface. A constant horizontal force of magnitude *F* then acts on the box, accelerating it to the right. You observe that it takes the box 3.4 seconds to travel 13 meters. What is the magnitude of the force *F*? 314) _____

315) A 590-kg rocket is at rest on the launch pad. What upward thrust force is needed to accelerate the rocket uniformly to an upward speed of 28 m/s in 3.3 s? 315) _____

316) A 958-N rocket is coming in for a vertical landing. It starts with a downward speed of 25 m/s and must reduce its speed to 0 m/s in 8.0 s for the final landing.
(a) During this landing maneuver, what must be the thrust due to the rocket's engines?
(b) What must be the direction of the engine thrust force? 316) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
317) Calculate the average force a bumper would have to exert to bring a 1200-kg car to rest in 15 cm when the car had an initial speed of 2.0 m/s (about 4.5 mph). 317) _____

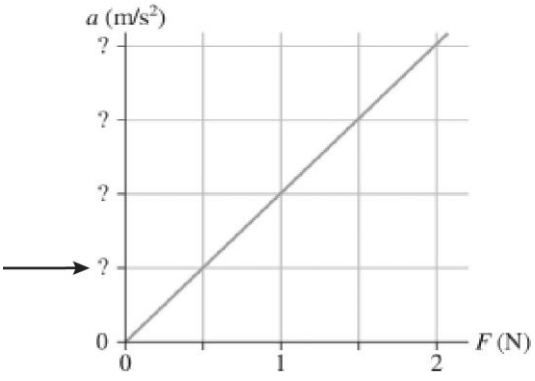
A) 6.5×10^5 N
B) 1.6×10^4 N
C) 5.4×10^4 N
D) 1.8×10^4 N
E) 3.2×10^4 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
318) A 10-kg object is hanging by a very light wire in an elevator that is traveling upward. The tension in the rope is measured to be 75 N. What are the magnitude and direction of the acceleration of the elevator? 318) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
319) 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? 319) _____

A) 9.81 m/s^2 B) 0.206 m/s^2 C) 46.9 m/s^2 D) 0.422 m/s^2 E) 4.91 m/s^2

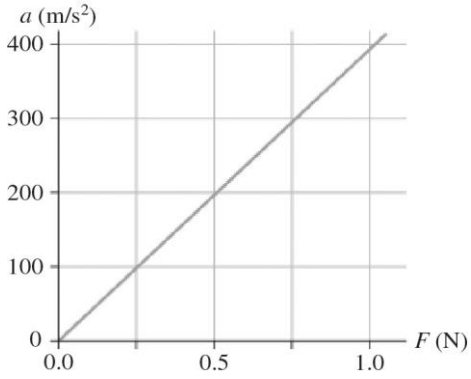
320) The figure shows an acceleration-versus-force graph for a 125-g object. What should be the value of the first tick-mark on the vertical scale, as indicated by the arrow in the figure?



320) _____

A) 0.00800 B) 8 C) 4 D) 0.00400

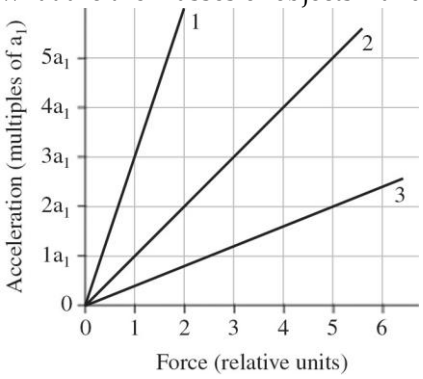
321) The figure shows an object's acceleration-versus-force graph. What is the mass of this object?



321) _____

A) 2.5 g B) 1.6 g C) 400,000 g D) 630 g

322) The figure shows an acceleration-versus-force graph for three objects pulled by wires. If the mass of object 2 is 36 kg, what are the masses of objects 1 and 3?



322) _____

A) 72 kg and 18 kg B) 12 kg and 90 kg C) 12 kg and 72 kg D) 90 kg and 12 kg

323) A 50.0-kg crate is being pulled along a horizontal smooth surface. The pulling force is 10.0 N and is directed 20.0° above the horizontal. What is the magnitude of the acceleration of the crate? 323) _____

A) 0.200 m/s^2
B) 0.188 m/s^2
C) 0.376 m/s^2
D) 0.0728 m/s^2
E) 0.0684 m/s^2

324) A 40-kg box is being pushed along a horizontal smooth surface. The pushing force is 15 N directed at an angle of 15° below the horizontal. What is the magnitude of the acceleration of the crate? 324) _____

A) 0.47 m/s^2 B) 0.36 m/s^2 C) 0.16 m/s^2 D) 0.68 m/s^2 E) 0.39 m/s^2

325) A 1000-kg barge is being towed by means of two horizontal cables. One cable is pulling with a force of 80.0 N in a direction 30.0° west of north. In what direction should the second cable pull so that the barge will accelerate northward, if the force exerted by the cable is 120 N? Assume that the water exerts no appreciable frictional drag on the barge. 325) _____

A) 19.5° east of north
B) 21.1° east of north
C) 54.7° east of north
D) 47.5° east of north

E) 39.0° east of north

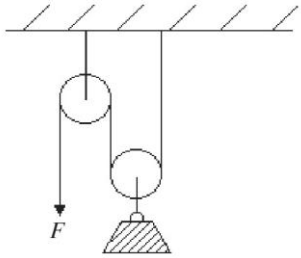
326) Two forces act on a 55-kg object. One force has magnitude 65 N directed 59° clockwise from the positive *x*-axis, and the other has a magnitude 35 N at 32° clockwise from the positive *y*-axis. What is the magnitude of this object's acceleration? 326) _____

A) 1.1 m/s^2 B) 1.7 m/s^2 C) 1.3 m/s^2 D) 1.5 m/s^2

327) A tightrope walker walks across a 30-m long wire tied between two poles. The center of the wire is displaced vertically downward by 1.0 m when he is halfway across. If the tension in both halves of the wire at this point is 6294 N, what is the mass of the tightrope walker? Neglect the mass of the wire. 327) _____

A) 74 kg B) 91 kgC) 85 kg D) 43 kg

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
328) A 30.0-kg load is being held in place using massless wires in the ideal pulley arrangement shown in the figure. What is the magnitude of the force *F*?



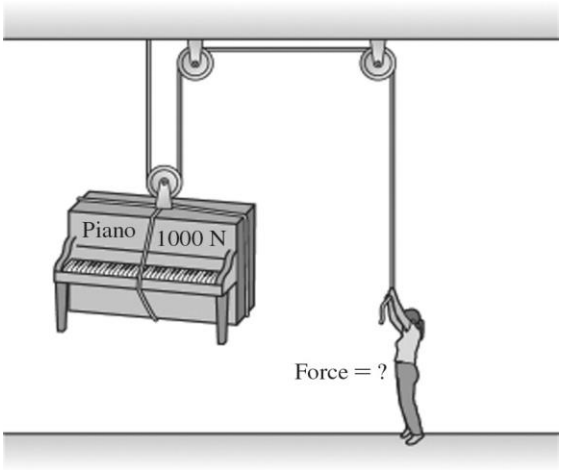
328) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
329) An object is being acted upon by three forces and as a result moves with a constant velocity. One force is 60.0 N along the +*x*-axis, and the second is 75.0 N along the +*y*-axis. What is the magnitude of the third force? 329) _____

A) 135 N B) 67.5 N C) 15.0 N D) 48.0 N E) 96.0 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
330) An object is being acted upon by three forces and moves with a constant velocity. One force is 60 N along the +*x*-axis, the second is 75 N along a direction making a counterclockwise angle of 150° with the +*x*-axis.
(a) What is the magnitude of the third force?
(b) What is the direction of the third force, measured clockwise from the +*x*-axis? 330) _____

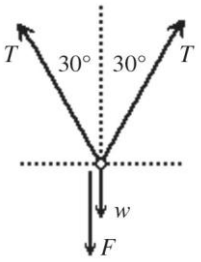
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
331) A piano mover raises a 1000-N piano at a constant speed using a very light rope in a frictionless pulley system, as shown in the figure. With what force is the mover pulling down on the rope?



331) _____

A) 250 N
B) 2000 N
C) 500 N
D) 1000 N
E) Depends on the speed of the piano.

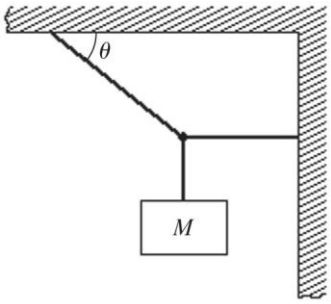
332) A 6.00-kg ornament is held at rest by two light wires that form 30° angles with the vertical, as shown in the figure. An external force of magnitude *F* acts vertically downward on the ornament. The tension exerted by each of the two wires is denoted by *T*. A free-body diagram, showing the four forces that act on the box, is shown in the figure. If the magnitude of force *F* is 410 N, what is the magnitude of the tension *T*?



332) _____

A) 271 N B) 376 N C) 188 N D) 235 N E) 470 N

333) The figure shows a block of mass *M* hanging at rest. The light wire fastened to the wall is horizontal and has a tension of 38 N. The wire fastened to the ceiling is also very light, has a tension of $59\,\text{N}$, and makes an angle θ with the ceiling. Find the angle θ.



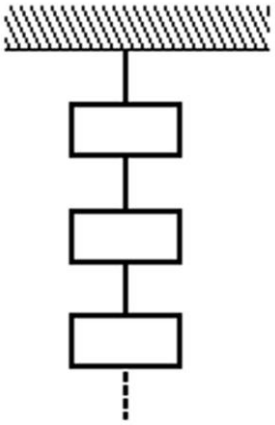
333) _____

A) 45° B) 65° C) 50° D) 40° E) 33°

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

334) A very light wire is used to hang a series of 8.0-kg bricks. This wire will break if the tension in it exceeds 450 N. The

bricks are hung one below the other from a hook in the ceiling using this wire, as shown in the figure.
(a) How many whole bricks can be hung without breaking the wire?



(b) If you add one more brick to the number found in part (a), which string will break? 334) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

335) A 400-kg box is lifted vertically upward with constant velocity by means of two cables pulling at 40.0° on either side of the vertical direction. What is the tension in each cable? 335) _____

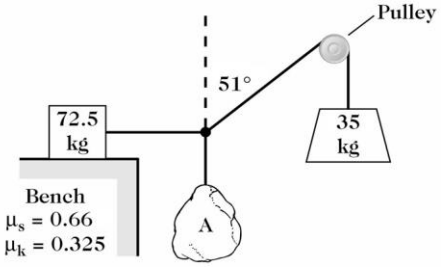
A) 400 N B) 231 N C) 2560 N D) 800 N E) 3920 N

336) A 10.0-kg picture is held in place by two wires, the first one hanging at 50.0° to the left of the vertical and the second one at 45.0° to the right of the vertical. What is the tension in the first wire? 336) _____

A) 50.8 N B) 69.6 N C) 23.8 N D) 98.1 N E) 69.4 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

337) Three objects are connected by weightless flexible strings as shown in the figure. The pulley has no appreciable mass or friction, and the string connected to the block on the horizontal bench pulls on it parallel to the bench surface. The coefficients of friction between the bench and the block on it are $\mu_S = 0.66$ and $\mu_K = 0.325$. You observe that this system remains at rest.
(a) Find the mass of the hanging object A.
(b) What is the magnitude of the friction force on the block on the bench?



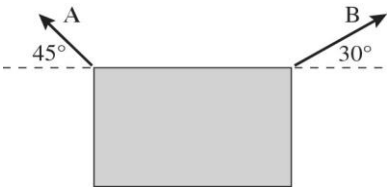
337) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

338) A load is being lifted vertically upwards by means of two cables attached to it. The first cable exerts a force of 600 N at an angle of 35.0° to the left of the vertical. The second cable exerts a force of 1300 N. At what angle to the right of the vertical is the second cable pulling? 338) _____

A) 75.8° B) 30.8° C) 15.4° D) 67.8° E) 16.2°

339) A 10-kg sign is held by two ropes as shown in the figure. What is the tension on rope A?



339) _____

A) 98 N B) 69 N C) 88 N D) 72 N E) 44 N

340) A 3.0-kg and a 5.0-kg box rest side-by-side on a perfectly smooth, level floor. A horizontal force of 32 N is applied to the 3.0-kg box pushing it against the 5.0-kg box, and, as a result, both boxes slide along the floor. How hard do the two boxes push against each other? 340) _____

A) 20 N B) 24 N C) 32 N D) 12 N E) 0 N

341) A 3.0-kg and a 5.0-kg box rest side-by-side on a smooth, level floor. A horizontal force of 32 N is applied to the 5.0-kg box pushing it against the 3.0-kg box, and, as a result, both boxes slide along the floor. How hard do the two boxes push against each other? 341) _____

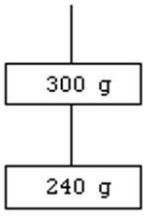
A) 12 N B) 20 N C) 24 N D) 0 N E) 32 N

342) Three boxes rest side-by-side on a smooth, horizontal floor. Their masses are 5.0 kg, 3.0 kg, and 2.0 kg, with the 3.0-kg mass in the center. A force of 50 N pushes on the 5.0-kg box, which pushes against the other two boxes. What magnitude force does the 5.0-kg box exert on the 3.0-kg box? 342) _____

A) 50 N B) 25 N C) 0 N D) 10 N E) 40 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

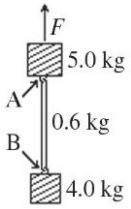
343) As shown in the figure, two blocks are connected by a very light string, and the upper block is pulled upward by a different string. The masses of the upper and lower blocks are 300 g and 240 g, respectively. The string between the blocks will break if its tension exceeds 3.6 N, and the string that pulls the combination upward will break if its tension exceeds 7.8 N.
(a) What is the largest upward acceleration that the blocks can be given without either string breaking?
(b) If the upward acceleration is slightly higher than this, which string breaks, the upper one or the lower one?



343) _____

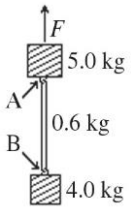
344) A locomotive is pulling 9 freight cars, each of which is loaded with the same weight. The mass of each loaded car is $37{,}000\ \text{kg}$, and we can neglect friction on these 9 cars. If the train is accelerating forward at $0.81\ \text{m/s}^2$ on a level track, what is the tension in the coupling between the second and third cars? (The car nearest the locomotive is counted as the first car.) 344) _____

345) A 5.0-kg block and a 4.0-kg block are connected by a 0.6 kg rod, as shown in the figure. The links between the blocks and the rod are denoted by A and B. A vertical upward force of magnitude *F* is applied to the upper block. The blocks and rod assembly are moving downward at constant velocity of 85 cm/s.
(a) What is the magnitude of the applied force *F*?
(b) What magnitude force does link A exert?



345) _____

346) A 5.0-kg block and a 4.0-kg block are connected by a 0.6 kg rod, as shown in the figure. The links between the blocks and the rod are denoted by A and B. A vertical upward force of magnitude *F* of magnitude 150 N is applied to the upper block. What magnitude force does each of the links A and B exert?



346) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

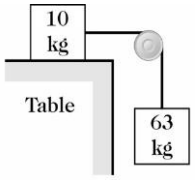
347) A 3.0-kg mass and a 5.0-kg mass hang vertically at the opposite ends of a very light rope that goes over an ideal pulley. If the masses are gently released, what is the resulting acceleration of the masses? 347) _____

A) 2.5 m/s^2 B) 6.1 m/s^2 C) 3.7 m/s^2 D) 4.9 m/s^2 E) 0.00 m/s^2

348) A 3.0-kg mass and a 5.0-kg mass hang vertically at the opposite ends of a rope that goes over an ideal pulley. If the masses are gently released from rest, how long does it take for the 3.0-kg mass to rise by 1.0 m? 348) _____

A) 0.74 s B) 0.90 s C) 0.82 s D) 1.8 s E) 0.41 s

349) As shown in the figure, a 10-kg block on a perfectly smooth horizontal table is connected by a horizontal string to a 63-kg block that is hanging over the edge of the table. What is the magnitude of the acceleration of the 10-kg block when the other block is gently released?



349) _____

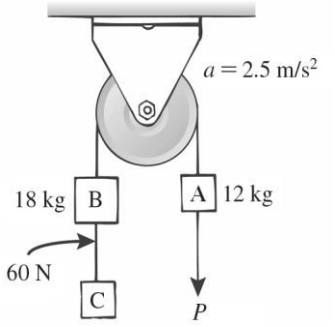
A) 8.5 m/s^2 B) 7.5 m/s^2 C) 8.1 m/s^2 D) 9.0 m/s^2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

350) Three blocks, light connecting ropes, and a light frictionless pulley comprise a system, as shown in the figure. An external force of magnitude *P* is applied downward on block A, causing block A to accelerate downward at a constant 2.5 m/s^2. The tension in the rope connecting block B and block C is equal to 60 N.

(a) What is the magnitude of the force *P*?

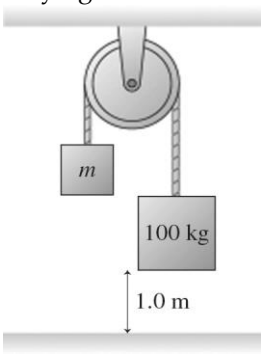
(b) What is the mass of block C?



350) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

351) The figure shows a 100-kg block being released from rest from a height of 1.0 m. It then takes 0.53 s for it to reach the floor. What is the mass m of the block on the left? There is no friction or mass in the pulley, and the connecting rope is very light.



351) _____

A) 16 kg B) 11 kgC) 14 kg D) 13 kg

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

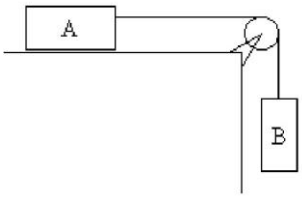
352) A locomotive is pulling three train cars along a level track with a force of 100,000 N. The car next to the locomotive has a mass of 80,000 kg, the next one, 50,000 kg, and the last one, 70,000 kg. You can neglect the friction on the cars being pulled.

(a) What is the magnitude of the force between that the 80,000-kg car exerts on the 50,000-kg car?

(b) What is the magnitude of the force that the 50,000-kg car exerts on the 70,000-kg car? 352) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

353) In the figure, block A has a mass of 3.00 kg. It rests on a smooth horizontal table and is connected by a very light horizontal string over an ideal pulley to block B, which has a mass of 2.00 kg. When block B is gently released from rest, how long does it take block B to travel 80.0 cm?



353) _____

A) 0.404 s B) 0.785 s C) 0.639 s D) 0.494 s E) 0.935 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

354) A 55-kg box rests on a horizontal surface. The coefficient of static friction between the box and the surface is 0.30, and the coefficient of kinetic friction is 0.20. What horizontal force must be applied to the box to cause it to start sliding along the surface? 354) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

355) The coefficients of static and kinetic friction between a 3.0-kg box and a horizontal desktop are 0.40 and 0.30, respectively. What is the force of friction on the box when a 15-N horizontal push is applied to the box? 355) _____

A) 4.5 N B) 15 N C) 12 N D) 6.0 N E) 8.8 N

356) An object slides on a level floor. It slows and comes to a stop with a constant acceleration of magnitude 2.4 m/s^2. What is the coefficient of kinetic friction between the object and the floor? 356) _____

A) 0.48
B) 0.24
C) 0.12
D) It is impossible to determine without knowing the mass of the object.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

357) A bulldozer attempts to drag a log weighing 500 N along the rough horizontal ground. The cable attached to the log makes an angle of 30° above the ground. The coefficient of static friction between the log and the ground is 0.50, and the coefficient of kinetic friction is 0.35. What minimum tension is required in the cable in order for the log to begin to slide?
357) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

358) A policeman investigating an accident measures the skid marks left by a car on the horizontal road. He determines that the distance between the point that the driver slammed on the brakes (thereby locking the wheels) and the point where the car came to a stop was 28.0 m. From a reference manual he determines that the coefficient of kinetic friction between the tires and the road under the prevailing conditions was 0.300. How fast was the car going when the driver applied the brakes? 358) _____

A) 45.7 m/s B) 32.9 m/s C) 12.8 m/s D) 10.7 m/s E) 21.4 m/s

359) A 50-kg box is being pushed along a horizontal surface. The coefficient of static friction between the box and the ground is 0.65, and the coefficient of kinetic friction is 0.35. What horizontal force must be exerted on the box for it to accelerate at 1.2 m/s^2? 359) _____

A) 230 N B) 490 N C) 170 N D) 120 N E) 60 N

360) 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? 360) _____

A) 220 N B) 620 N C) 32 N D) 200 N E) 250 N

361) A baseball player is running to second base at 5.03 m/s. When he is 4.80 m from the plate he goes into a slide. The coefficient of kinetic friction between the player and the ground is 0.180, and the coefficient of static friction is 3.14. What is his speed when he reaches the plate? 361) _____

A) 2.56 m/s
B) 4.47 m/s
C) 2.89 m/s
D) 1.96 m/s
E) He stops before reaching the plate.

362) A 55-kg box rests on a horizontal surface. The coefficient of static friction between the box and the surface is 0.30. A

horizontal 140-N force is applied to the box. What is the friction force on the box? 362) _____

A) 140 N B) 160 N C) 0.00 N D) 16.5 N E) 42 N

363) A horizontal 52-N force is needed to slide a 50-kg box across a flat surface at a constant velocity of 3.5 m/s. What is the coefficient of kinetic friction between the box and the floor? 363) _____

A) 0.10 B) 0.13 C) 0.09 D) 0.11

364) In a shuffleboard game, the puck slides a total of 12 m on a horizontal surface before coming to rest. If the coefficient of kinetic friction between the puck and board is 0.10, what was the initial speed of the puck? 364) _____

A) 4.8 m/s B) 48.5 m/s C) 4.3 m/s D) 3.8 m/s

365) During a hockey game, a puck is given an initial speed of 10 m/s. It slides 50 m on the horizontal ice before it stops due to friction. What is the coefficient of kinetic friction between the puck and the ice? 365) _____

A) 0.090 B) 0.12 C) 0.10 D) 0.11

366) 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? 366) _____

A) 30 m B) 34 m C) 46 m D) 37 m

367) A flatbed truck is carrying a 20.0-kg crate along a level road. The coefficient of static friction between the crate and the bed is 0.400, and the coefficient of kinetic friction is 0.300. What is the maximum acceleration that the truck can have if the crate is to stay in place relative to the truck? 367) _____

A) 7.84 m/s^2 B) 3.92 m/s^2 C) 78.5 m/s^2 D) 8.00 m/s^2 E) 196 m/s^2

368) You push downward on a trunk at an angle 25° below the horizontal with a force of 750 N. If the trunk is on a flat surface and the coefficient of static friction between the surface and the trunk is 0.61, what is the most massive trunk you will be able to move? 368) _____

A) 93 kg B) 81 kg C) 112 kg D) 73 kg

369) Jason takes off across level water on his jet-powered skis. The combined mass of Jason and his skis is 75 kg (the mass of the fuel is negligible). The skis produce a forward thrust of 200 N and have a coefficient of kinetic friction with water of 0.10. Unfortunately, the skis run out of fuel after only 90 s. What is Jason's top speed? 369) _____

A) 24 m/s B) 150 m/s C) 240 m/s D) 90 m/s

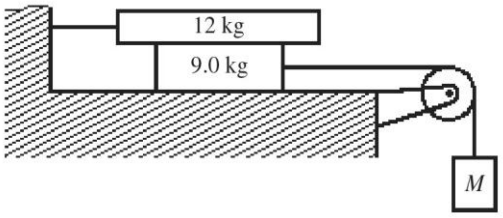
370) Jason takes off across level water on his jet-powered skis. The combined mass of Jason and his skis is 75 kg (the mass of the fuel is negligible). The skis produce a forward thrust of 200 N and have a coefficient of kinetic friction with water of 0.10. Unfortunately, the skis run out of fuel after only 41 s. How far from his starting point has Jason traveled when he finally coasts to a stop? 370) _____

A) 1400 m B) 3900 m C) 2900 m D) 2000 m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

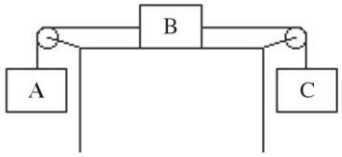
371) You push horizontally on a 120-N box that is initially resting on a horizontal table. The coefficient of static friction between the box and the table is 0.75, and the coefficient of kinetic friction is 0.40. Find the friction force on the box if the push is equal to (a) 84 N; (b) 94 N. 371) _____

372) The figure shows a system consisting of three blocks, a light frictionless pulley, and light connecting ropes that act horizontally on the upper two blocks. The 9.0-kg block is on a perfectly smooth horizontal table. The surfaces of the 12-kg block are rough, with $\mu_k = 0.30$ between the 12-kg and 9.0-kg blocks. The mass M of the hanging block is set so that it descends at a constant velocity of 3.25 m/s.
(a) What is the mass M of the hanging block?
(b) The mass M is now changed to 5.0 kg, causing it to accelerate downward after it is released. What is the acceleration of the hanging mass?



372) _____

373) As shown in the figure, block B on a horizontal tabletop is attached by very light horizontal strings to two hanging blocks, A and C. The pulleys are ideal, and the coefficient of kinetic friction between block B and the tabletop is 0.100. The masses of the three blocks are $m_A = 12.0$ kg, $m_B = 7.00$ kg, and $m_C = 10.0$ kg. Find the magnitude and direction of the acceleration of block B after the system is gently released and has begun to move.



373) _____

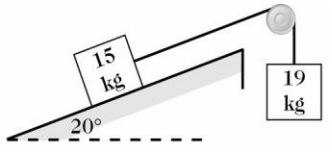
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
374) A flatbed truck is carrying a 20-kg crate up a sloping road. The coefficient of static friction between the crate and the bed is 0.40, and the coefficient of kinetic friction is 0.30. What is the maximum angle of slope that the truck can climb at constant speed if the crate is to stay in place? 374) _____

A) 17° B) 0.38° C) 13° D) 68° E) 22°

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
375) A 2.8-kg tool can move on a perfectly smooth ramp that slants at 42° above the horizontal. What are the magnitude and direction of the acceleration of this tool if it is sliding (a) up the ram, (b) down the ramp? 375) _____

376) A slanted roof rises at 35° above the horizontal, and the straight-line distance from the top of the roof to the bottom edge is 4.5 m. The roof is covered with ice, so it offers no friction to objects sliding on it. A piece of ice at the top suddenly breaks loose and begins to slide down from rest.
(a) How long will it take for the ice to reach the bottom edge of the roof?
(b) How fast will the ice be traveling just as it reaches the bottom edge? 376) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
377) A 15-kg block is on a frictionless ramp that is inclined at 20° above the horizontal. It is connected by a very light string over an ideal pulley at the top edge of the ramp to a hanging 19-kg block, as shown in the figure. The string pulls on the 15-kg block parallel to the surface of the ramp. Find the magnitude of the acceleration of the 19-kg block after the system is gently released?

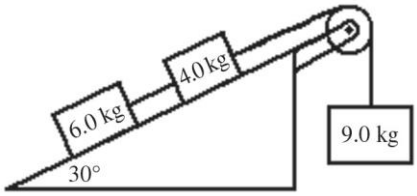


377) _____

A) 4.5 m/s^2 B) 3.8 m/s^2 C) 4.0 m/s^2 D) 4.2 m/s^2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

378) A system consisting of blocks, a light frictionless pulley, a frictionless incline, and very light connecting wires is shown in the figure. The wires pull on the left-hand blocks parallel to the surface of the ramp. The 9.0-kg block accelerates downward when the system is released gently from rest.
(a) What is the magnitude of the acceleration of the 9.0-kg block?
(b) What is the tension in the wire connecting the two blocks on the incline?



378) _____

379) A 150-N crate is being pulled up a perfectly smooth ramp that slopes upward at 15° by a pull that is directed at 30° above the surface of the ramp. What is the magnitude of the pull required to make the crate move up the ramp at a constant velocity of 1.75 m/s? 379) _____

380) A 7.5-kg stone moves up frictionless hill that slopes upward at 41° above the horizontal. If the stone has an initial velocity of 8.5 m/s at the bottom, how far (as measured along the surface of the hill) will it go before stopping? 380) _____

381) A 5.0-kg box slides on the surface on a ramp that rises at 37° above the horizontal. The coefficient of kinetic friction between the box and the surface of the ramp is 0.60. What are the magnitude and direction of the acceleration of the box if it is sliding (a) up the ramp, (b) down the ramp? 381) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

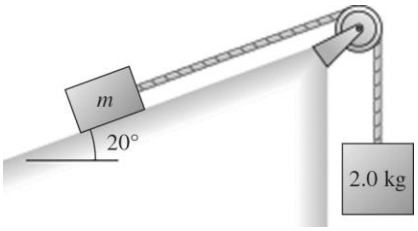
382) A 6.0-kg box slides down an inclined plane that makes an angle of 39° with the horizontal. If the coefficient of kinetic friction is 0.40, at what rate does the box accelerate down the slope? 382) _____

A) 4.1 m/s^2 B) 3.7 m/s^2 C) 3.4 m/s^2 D) 3.1 m/s^2

383) A 200-g hockey puck is launched at an initial speed of 16 m/s up a metal ramp that is inclined at a 30° angle. The coefficients of static and kinetic friction between the hockey puck and the metal ramp are $\mu_S = 0.40$ and $\mu_K = 0.30$, respectively. What vertical height does the puck reach above its starting point? 383) _____

A) 13 cm B) 8.6 cm C) 17 cm D) 4.2 cm

384) The figure shows a block of mass *m* resting on a 20° slope. The block has coefficients of friction $\mu_S = 0.64$ and $\mu_K = 0.54$ with the surface of the slope. It is connected using a very light string over an ideal pulley to a hanging block of mass 2.0 kg. The string above the slope pulls parallel to the surface. What is the minimum mass *m* so the system will remain at rest when it is released from rest?



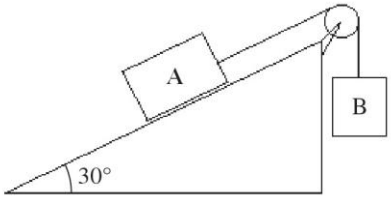
384) _____

A) 1.3 kg B) 3.3 kg C) 3.6 kg D) 2.1 kg

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

385) A 200-g hockey puck is launched up a ramp that is inclined at a 30° angle above the horizontal. The coefficients of static and kinetic friction between the puck and the ramp are $\mu_s = 0.40$ and $\mu_k = 0.30$, respectively, and the puck's initial velocity at the base is 3.8 m/s parallel to the sloping surface of the ramp. What speed does the puck have when it slides back down to its starting point? 385) _____

386) Two packages are connected by a very light string that goes over an ideal pulley as shown in the figure. Package A has a mass of 3.0 kg and can slide along a rough plane inclined at 30° above the horizontal. The string acts on package A parallel to the surface of the plane. The coefficient of static friction between package A and the plane is 0.40. What minimum mass should package B have in order to start package A sliding up the ramp?



386) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

387) A 50.0-kg block is being pulled up a 16.0° slope by a force of 250 N that is parallel to the slope. The coefficient of kinetic friction between the block and the slope is 0.200. What is the acceleration of the block? 387) _____

A) 0.158 m/s^2 B) 0.412 m/s^2 C) 0.260 m/s^2 D) 0.528 m/s^2 E) 0.983 m/s^2

CLO5 Work, energy and power

388) An ornament of mass 40.0 g is attached to a vertical ideal spring with a force constant (spring constant) of 20.0 N/m. The ornament is then lowered very slowly until the spring stops stretching. How much does the spring stretch? 388) _____

A) 0.800 m B) 0.200 m C) 0.0196 m D) 0.00200 m E) 0.0816 m

389) A force of $30\,\text{N}$ stretches a very light ideal spring $0.73\,\text{m}$ from equilibrium. What is the force constant (spring constant) of the spring? 389) _____

A) 34 N/m B) 41 N/m C) 22 N/m D) 46 N/m

390) A very light ideal spring stretches by $21.0\,\text{cm}$ when it is used to hang a 135-N object. What is the weight of a piece of electronic equipment that would stretch the spring by $44.9\,\text{cm}$ if you hung the equipment using the spring? 390) _____

A) 289 N B) 176 N C) 63 N D) 405 N

391) An object attached to a spring is pulled across a horizontal frictionless surface. If the force constant (spring constant) of the spring is 45 N/m and the spring is stretched by 0.88 m when the object is accelerating at $1.4\,\text{m/s}^2$, what is the mass of the object? 391) _____

A) 28 kg B) 31 kgC) 36 kg D) 24 kg

392) A 3.0-kg brick rests on a perfectly smooth ramp inclined at 34° above the horizontal. The brick is kept from sliding down the plane by an ideal spring that is aligned with the surface and attached to a wall above the brick. The spring has a spring constant (force constant) of 120 N/m. By how much does the spring stretch with the brick attached? 392) _____

A) 360 cm B) 36 cm C) 240 cm D) 14 cm E) 24 cm

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

393) A very light ideal spring having a spring constant (force constant) of 8.2 N/cm is used to lift a 2.2-kg tool with an upward acceleration of 3.25 m/s^2. If the spring has negligible length when it us not stretched, how long is it while it is pulling the tool upward? 393) _____

394) A very light ideal spring with a spring constant (force constant) of 2.5 N/cm pulls horizontally on an 18-kg box that is resting on a horizontal floor. The coefficient of static friction between the box and the floor is 0.65, and the coefficient of kinetic friction is 0.45.
(a) How long is the spring just as the box is ready to move?
(b) If the spring pulls the box along with a constant forward velocity of 1.75 m/s, how long is the spring?
(c) How long is the spring if it pulls the box forward at a constant 2.75 m/s? 394) _____

395) A very light ideal spring of spring constant (force constant) 2.5 N/cm is 15 cm long when nothing is attached to it. It is now used to pull horizontally on a 12.5-kg box on a perfectly smooth horizontal floor. You observe that the box starts from rest and moves 96 cm during the first 1.6 s of its motion with constant acceleration. How long is the spring during this motion? 395) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

396) How much work would a child do while pulling a 12-kg wagon a distance of $4.3\,\text{m}$ with a $22\,\text{N}$ force? 396) _____

A) 95 J B) 52 J C) 109 J D) 67 J

397) A child does 350 J of work while pulling a box from the ground up to his tree house at a steady speed with a light rope. The tree house is $4.0\,\text{m}$ above the ground. What is the mass of the box? 397) _____

A) 6.7 kg B) 8.0 kg C) 8.9 kg D) 5.3 kg

398) You carry a 7.0-kg bag of groceries $1.2\,\text{m}$ above the ground at constant speed across a $2.7\,\text{m}$ room. How much work do you do on the bag in the process? 398) _____

A) 82 J B) 0.00 JC) 185 J D) 157 J

399) It requires 0.30 kJ of work to fully drive a stake into the ground. If the average resistive force on the stake by the ground is $828\,\text{N}$, how long is the stake? 399) _____

A) 0.41 m B) 0.36 m C) 0.23 m D) 0.31 m

400) A crane lifts a 425 kg steel beam vertically upward a distance of $95\,\text{m}$. How much work does the crane do on the beam if the beam accelerates upward at 1.8 m/s^2? Neglect frictional forces. 400) _____

A) 2.7×10^5J B) 4.7×10^5 J C) 3.2×10^5 J D) 4.0×10^5 J

401) A traveler pulls on a suitcase strap at an angle 36° above the horizontal. If $555\,\text{J}$ of work are done by the strap while moving the suitcase a horizontal distance of $15\,\text{m}$, what is the tension in the strap? 401) _____

A) 37 N B) 52 N C) 56 N D) 46 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
402) A 500-kg elevator is pulled upward with a constant force of 5500 N for a distance of 50.0 m.
(a) What is the work done by the 5500-N force?
(b) What is the work done by gravity?
(c) What is the net work done on the elevator? 402) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
403) A 30-N box is pulled upward 6.0 m along the surface of a ramp that rises at 37° above the horizontal. How much work does gravity do on the box during this process? 403) _____

A) -1100 J B) 120 J C) -140 J D) -110 J E) -180 J

404) 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? 404) _____

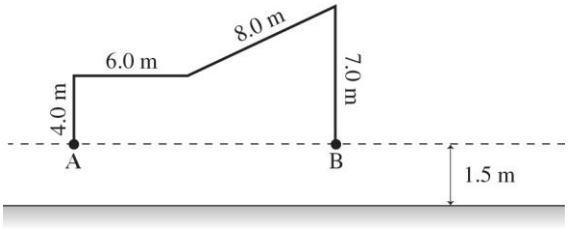
A) 720 J B) 575 J C) 433 J D) 185 J

405) Find the net work done by friction on a box that moves in a complete circle of radius $1.82\,\text{m}$ on a uniform horizontal floor. The coefficient of kinetic friction between the floor and the box is 0.25, and the box weighs $65.0\,\text{N}$. 405) _____

A) 1800 J B) 190 J C) 370 J D) 0 J

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
406) A 2.0-kg object is lifted vertically through 3.00 m by a 150-N force. How much work is done on the object by gravity during this process? 406) _____

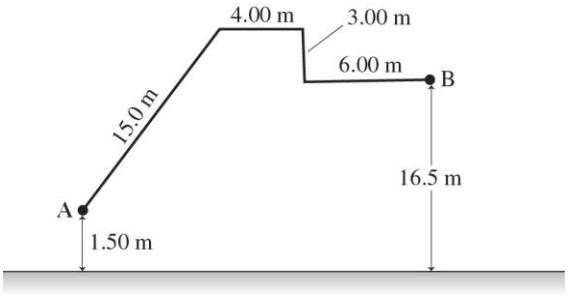
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
407) A person carries a 25.0-N rock through the path shown in the figure, starting at point A and ending at point B. The total time from A to B is 1.50 min. How much work did gravity do on the rock between A and B?



407) _____

A) 625 J B) 20.0 J C) 0 J D) 75 J E) 275 J

408) A person carries a 2.00-N pebble through the path shown in the figure, starting at point A and ending at point B. The total time from A to B is 6.75 min. How much work did gravity do on the rock between A and B?



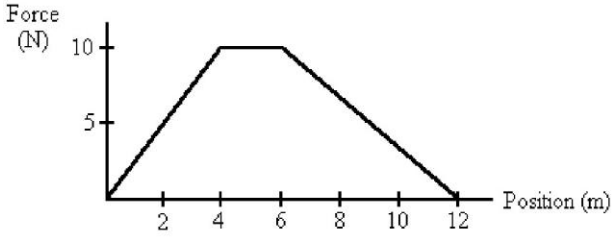
408) _____

A) 30.0 J B) -36.0 J C) -30.0 J D) -56.0 J E) 56.0 J

409) A stone with a mass of 1.0 kg is tied to the end of a light string which keeps it moving in a circle with a constant speed of 4.0 m/s on a perfectly smooth horizontal tabletop. The radius of the path is 0.60 m. How much work does the tension in the string do on the stone as it makes one-half of a complete circle? 409) _____

A) 0 J B) 100 J C) 80 J D) 40 J E) 3.8 J

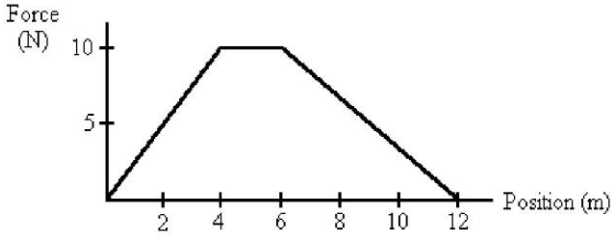
410) A force acts on an object, causing it to move parallel to the force. The graph in the figure shows this force as a function of the position of the object. How much work does the force do as the object moves from 4 m to 6 m?



410) _____

A) 40 J B) 20 J C) 0 J D) 70 J E) 30 J

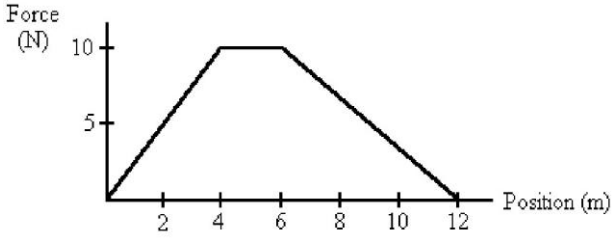
411) A force acts on an object, causing it to move parallel to the force. The graph in the figure shows this force as a function of the position of the object. How much work does the force do as the object moves from 0 m to 4 m?



411) _____

A) 0 J B) 30 J C) 40 J D) 20 J E) 70 J

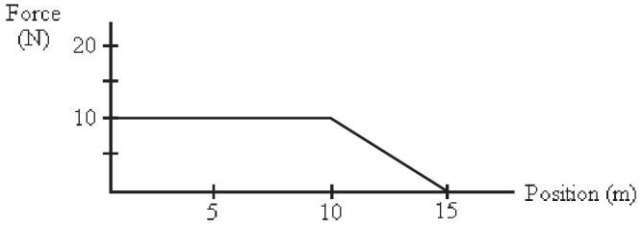
412) A force acts on an object, causing it to move parallel to the force. The graph in the figure shows this force as a function of the position of the object. How much work does the force do as the object moves from 6 m to 12 m?



412) _____

A) 0 J B) 20 J C) 30 J D) 70 J E) 40 J

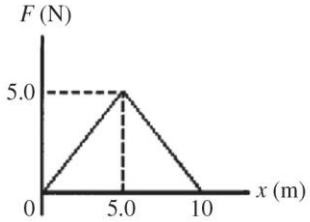
413) A force acts on an object, causing it to move parallel to the force. The graph in the figure shows this force as a function of the position of the object. How much work does the force do as the object moves from 0 to 15 m?



413) _____

A) 100 J B) 25 J C) 150 J D) 125 J E) 50 J

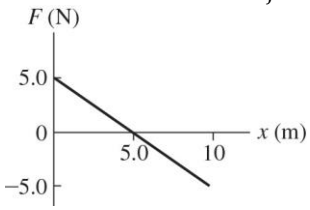
414) The net force that an animal exerts on a large piece of fruit it has found is observed and is shown in the graph in the figure. If the force is parallel to the motion of the fruit, how much work did the animal do during the encounter?



414) _____

A) 0 J B) 22 J C) 12.5 J D) 50 J E) 25 J

415) The resultant force on an object over a 0.50-s time interval is plotted in the graph in the figure. How much work did this force do on the object during the 0.50-s interval?



415) _____

A) 22 J B) 12.5 J C) 0 J D) 50 J E) -25 J

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

416) How fast must a 6.0-kg cat run to have a kinetic energy of 150 J? 416) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

417) How much kinetic energy does a 0.30-kg stone have if it is thrown at 44 m/s? 417) _____

A) 440 J B) 510 J C) 580 J D) 290 J

418) 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? 418) _____

A) 1/2 B) 1/8 C) 1/4 D) 1/16

419) A 1000-kg car is moving at 15 km/h. If a 2000-kg truck has 23 times the kinetic energy of the car, how fast is the truck moving? 419) _____

A) 72 km/h B) 51 km/h C) 61 km/h D) 41 km/h

420) What is the minimum energy needed to change the speed of a 1600-kg sport utility vehicle from 15.0 m/s to 40.0 m/s? 420) _____

A) 10.0 kJ B) 0.960 MJ C) 1.10 MJ D) 40.0 kJ E) 20.0 kJ

421) A 1.0-kg object moving in a certain direction has a kinetic energy of 2.0 J. It hits a wall and comes back with half its original speed. What is the kinetic energy of this object at this point? 421) _____

A) 1.0 J B) 0.50 J C) 4.0 J D) 2.0 J E) 0.25 J

422) How much work must be done by frictional forces in slowing a 1000-kg car from $26.1\ \text{m/s}$ to rest? 422) _____

A) 4.09×10^5 J B) 2.73×10^5 J C) 3.41×10^5 J D) 4.77×10^5 J

423) 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. 423) _____

A) 30.8 m/s B) 25.2 m/s C) 22.4 m/s D) 28.0 m/s

424) A 10-kg dog is runnng with a speed of 5.0 m/s. What is the minimum work required to stop the dog in 2.40 s? 424) _____

A) 75 J B) 50 J C) 100 J D) 125 J

425) How large a net force is required to accelerate a 1600-kg SUV from rest to a speed of 25 m/s in a distance of 200 m? 425) _____

A) 1600 N B) 0 N C) 200 N D) 2500 N E) 400 N

426) A 100-N force has a horizontal component of 80 N and a vertical component of 60 N. The force is applied to a cart on a level frictionless floor. The cart starts from rest and moves 2.0 m horizontally along the floor due to this force. What is the cart's final kinetic energy? 426) _____

A) 120 J B) 160 J C) 200 J D) zero

427) A 1000-kg car experiences a net force of 9500 N while slowing down from 30 m/s to $15.9\ \text{m/s}$. How far does it travel while slowing down? 427) _____

A) 37 m B) 31 m C) 41 m D) 34 m

428) A stone initially moving at 8.0 m/s on a level surface comes to rest due to friction after it travels 11 m. What is the coefficient of kinetic friction between the stone and the surface? 428) _____

A) 0.43 B) 0.13 C) 0.30 D) 0.25 E) 0.80

429) A sled having a certain initial speed on a horizontal surface comes to rest after traveling 10 m. If the coefficient of kinetic friction between the object and the surface is 0.20, what was the initial speed of the object? 429) _____

A) 9.8 m/s B) 7.2 m/s C) 6.3 m/s D) 8.9 m/s E) 3.6 m/s

430) On an alien planet, an object moving at 4.0 m/s on the horizontal ground comes to rest after traveling a distance of 10 m. If the coefficient of kinetic friction between the object and the surface is 0.20, what is the value of g on that planet? 430) _____

A) 4.0 m/s^2 B) 6.0 m/s^2 C) 12 m/s^2 D) 10 m/s^2 E) 8.0 m/s^2

431) A driver, traveling at 22 m/s, slows down her 2000 kg truck to stop for a red light. What work is done on the truck by the friction force of the road? 431) _____

A) -2.2 × 10^4 J B) -4.8 × 10^5 J C) -9.7 × 10^5 J D) -4.4 × 10^4 J

432) The kinetic friction force that a horizontal surface exerts on a 60.0-kg object is 50.0 N. If the initial speed of the object is 25.0 m/s, what distance will it slide before coming to a stop? 432) _____

A) 15.0 m B) 375 m C) 30.0 m D) 750 m

433) A stone is moving on a rough level surface. It has 24 J of kinetic energy, and the friction force on it is a constant 0.50 N. What is the maximum distance it can slide? 433) _____

A) 12 m B) 2.0 m C) 24 m D) 48 m

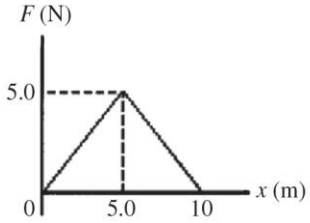
434) In a ballistics test, a 28-g bullet pierces a sand bag that is $30\,\text{cm}$ thick. If the initial bullet velocity was $55\,\text{m/s}$ and it emerged from the sandbag moving at $18\,\text{m/s}$, what was the magnitude of the friction force (assuming it to be constant) that the bullet experienced while it traveled through the bag? 434) _____

A) 130 N B) 1.3 N C) 13 N D) 38 N

435) A certain car traveling at 34.0 mph skids to a stop in 29 meters from the point where the brakes were applied. In approximately what distance would the car have stopped had it been going 105.4 mph? 435) _____

A) 90 m B) 158 m C) 51 m D) 279 m E) 29 m

436) The horizontal force that an animal exerts on a large fruit it has found is observed and is shown in the graph in the figure. If the fruit was initially sliding on the frictionless ground at 5.5 cm/s when the animal first grabbed it, by how much did the animal change its kinetic energy during this encounter?



436) _____

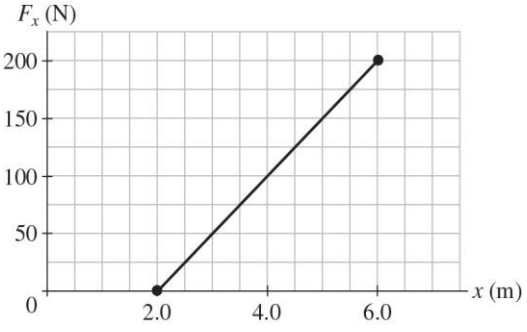
A) 12.5 J B) 50 J C) 22 J D) 25 J E) 0 J

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

437) The graph in the figure shows the *magnitude* of the net horizontal force F_x on a 25-kg package as a function of the position x of the package. Just before the force was applied, the package was originally sliding at 6.0 m/s in the $+x$ direction on a smooth horizontal floor. Find the x component of the velocity of the package just after the force has stopped in each of the following cases.

(a) The force is applied in the same direction as the original velocity of the box.

(b) The force is applied in the opposite direction to the original velocity of the box.



437) _____

438) How high a hill would a 75-kg hiker have to climb to increase her gravitational potential energy by 10,000 J? 438) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

439) You do 116 J of work while pulling your sister back on a fritctionless swing, whose chain is $5.10\ \text{m}$ long, until the swing makes an angle of 32.0° with the vertical. What is your sister's mass? 439) _____

A) 19.0 kg B) 17.6 kg C) 15.3 kg D) 13.0 kg

440) A tennis ball bounces on the floor three times, and each time it loses 23.0% of its energy due to heating. How high does it bounce after the third time, if we released it $4.0\ \text{m}$ from the floor? 440) _____

A) 240 cm B) 18 cm C) 180 cm D) 180 mm

441) A 10-kg mass, hung by an ideal spring, causes the spring to stretch 2.0 cm. What is the spring constant (force constant) for this spring? 441) _____

A) 49 N/cm
B) 0.20 N/cm
C) 20 N/m
D) 0.0020 N/cm
E) 5.0 N/cm

442) An ideal spring stretches by 21.0 cm when a 135-N object is hung from it. If instead you hang a fish from this spring, what is the weight of a fish that would stretch the spring by $31.0\ \text{cm}$? 442) _____

A) 199 N B) 279 N C) 91 N D) 145 N

443) 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? 443) _____

A) 0.00 J B) 1.0 J C) 3.0 J D) 2.0 J E) 4.0 J

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

444) You want to store 1,000 J of energy in an ideal spring when it is compressed by only 2.5 cm. What should be the force constant (spring constant) of this spring? 444) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

445) 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? 445) _____

A) 0.3 cm B) 5.7 mC) 5.7 cm D) 3.2 m E) 3.2 cm

446) If the work done to stretch an ideal spring by 4.0 cm is 6.0 J, what is the spring constant (force constant) of this spring? 446) _____

A) 7500 N/m B) 300 N/m C) 3000 N/m D) 3500 N/m E) 6000 N/m

447) An ideal spring has a spring constant (force constant) of 60 N/m. How much energy does it store when it is stretched by 1.0 cm? 447) _____

A) 600 J B) 60 J C) 0.0030 J D) 0.30 J

448) How much work is required to stretch an ideal spring of spring constant (force constant) 40 N/m from x = 0.20 m to x = 0.25 m if the unstretched position is at x = 0.00 m? 448) _____

A) 0.45 J B) 0.80 JC) 0.050 J D) 1.3 J

449) An ideal spring with a force constant (spring constant) of 15 N/m is initially compressed by 3.0 cm from its uncompressed position. How much work is required to compress the spring an *additional* 4.0 cm? 449) _____

A) 0.030 J B) 0.024 J C) 0.012 J D) 0.0068 J

450) It takes 87 J of work to stretch an ideal spring from 1.4 m to 2.9 m from equilibrium. What is the value of the spring constant (force constant) of this spring? 450) _____

A) 27 N/m B) 52 N/m C) 77 N/m D) 39 N/m

451) An ideal spring with a spring constant (force constant) of $22\ \text{N/m}$ is stretched from equilibrium to 2.9 m. How much work is done in the process? 451) _____

A) 121 J B) 47 J C) 93 J D) 186 J

452) A rock falls from a vertical cliff that is 4.0 m tall and experiences no significant air resistance as it falls. At what speed will its gravitational potential energy (relative to the base of the cliff) be equal to its kinetic energy? 452) _____

A) 3.1 m/s B) 8.9 m/s C) 4.4 m/s D) 6.3 m/s E) 13 m/s

453) A block slides down a frictionless inclined ramp and experiences no significant air resistance. If the ramp angle is 17.0° above the horizontal and the length of the surface of the ramp is $20.0\ \text{m}$, find the speed of the block as it reaches the bottom of the ramp, assuming it started sliding from rest at the top. 453) _____

A) 19.6 m/s B) 114 m/s C) 10.7 m/s D) 7.57 m/s

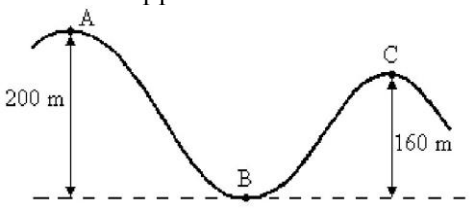
454) A prankster drops a water balloon from the top of a building. If the balloon is traveling at 29.1 m/s when it strikes a window ledge that is 1.5 m above the ground, how tall is the building? Neglect air resistance. 454) _____

A) 46 m B) 47 m C) 45 m D) 43 m

455) A spring-loaded dart gun is used to shoot a dart straight up into the air, and the dart reaches a maximum height of 24 meters. The same dart is shot up a second time from the same gun, but this time the spring is compressed only half as far (compared to the first shot). How far up does the dart go this time (neglect all friction and assume the spring is ideal)? 455) _____

A) 12 m B) 6.0 mC) 48 m D) 3.0 m

456) 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?



456) _____

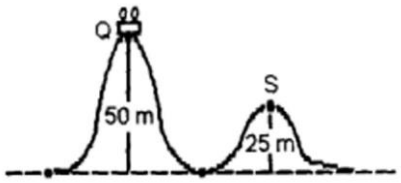
A) 20 m/s
B) 69 m/s
C) 0 m/s
D) 34 m/s
E) We cannot solve this problem without knowing the mass of the bead.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

457) A frictionless simple pendulum, with a small but dense 4.4-kg mass at the end and a length of 75 cm, is released from rest at an angle of 50° with the vertical.
(a) To what height above its lowest point does the mass swing on the other side?
(b) What is the speed of the mass at the bottom of the swing? 457) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

458) The figure shows a famous roller coaster ride. You can ignore friction. If the roller coaster leaves point Q from rest, what is its speed at the top of the 25-m peak (point S)?



458) _____

A) 120 m/s B) 44 m/s C) 62 m/s D) 22 m/s E) 10 m/s

459) What is the minimum energy needed to lift a 1.0-kg rocket to a height of 200 km and to give it a speed of 8.0 km/s at that height? (Neglect air resistance and the small decrease in g over that distance.) 459) _____

A) 34 J B) 34 MJ C) 34 GJ D) 34 kJ E) 34 TJ

460) Assuming negligible friction, what spring constant (force constant) would be needed by the spring in a "B-B gun" to fire a 10-g pellet to a height of 100 m if the spring is initially compressed by 0.10 m? 460) _____

A) 20 N/m
B) 20 N/cm
C) 2000 N/cm
D) 0.0020 N/m
E) 200 N/m

461) If a spring-operated gun can shoot a pellet to a maximum height of 100 m on Earth, how high could the pellet rise if fired on the Moon, where $g = 1.6\ m/s^2$? 461) _____

A) 3.6 km B) 160 m C) 17 m D) 100 m E) 610 m

462) A 60-kg skier pushes off the top of a frictionless hill with an initial speed of 4.0 m/s. How fast will she be moving after dropping 10 m in elevation? Air resistance is negligible. 462) _____

A) 49 m/s B) 0.15 km/s C) 0.20 km/s D) 10 m/s E) 15 m/s

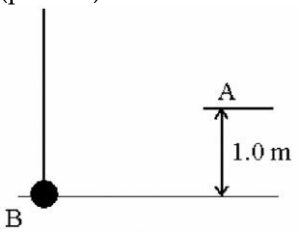
463) A toy rocket that weighs 10 N blasts straight up from ground level with an initial kinetic energy of 40 J. At the exact top of its trajectory, its total mechanical energy is 140 J. To what vertical height above the ground does it rise, assuming no air resistance? 463) _____

A) 24 m B) 10 m C) 14 m D) 1.0 m

464) A 5.0-N projectile leaves the ground with a kinetic energy of 220 J. At the highest point in its trajectory, its kinetic energy is 120 J. To what vertical height, relative to its launch point, did it rise if there was no air resistance? 464) _____

A) 20 m
B) 10 m
C) 44 m
D) 24 m
E) It is impossible to determine the height without knowing the angle of launch.

465) 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?



465) _____

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

466) A 1500-kg car moving at 25 m/s hits an initially uncompressed horizontal ideal spring with spring constant (force constant) of 2.0×10^6 N/m. What is the maximum distance the spring compresses? 466) _____

A) 0.34 m B) 0.51 m C) 0.17 m D) 0.68 m

467) A small but dense 2.0-kg stone is attached to one end of a very light rod that is 1.2 m long. The other end of the rod is attached to a frictionless pivot. The rod is raised until it is vertical, with the stone above the pivot. The rod is released and the stone moves in a vertical circle with no air resistance. What is the tension in the rod as the stone moves through the bottom of the circle? 467) _____

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

468) In a museum exhibit of a simple pendulum, a very small but dense 6.0-kg ball swings from a very light 2.5-m wire. The ball is released from rest when the pendulum wire makes a 65° angle with the vertical, and it swings in a circular arc with no appreciable friction or air resistance. What is the tension in the wire just as the ball swings through its lowest position? 468) _____

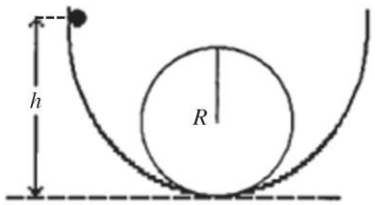
A) 130 N B) 0 N C) 59 N D) 11 N E) 68 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

469) A roller coaster starting from rest descends 35 meters in its initial drop and then rises 23 meters when it goes over the first hill, which has a circular shape over the top. If a passenger at the top of the hill feels an apparent weight equal to one-half of her normal weight, what is the radius of curvature of the first hill? Neglect any frictional losses. 469) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

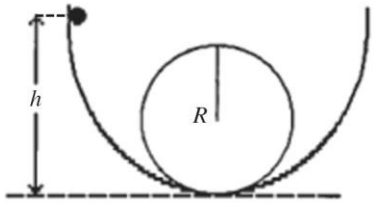
470) A roller coaster starts from rest at a height *h* at the left side of a loop-the-loop, as shown in the figure. It is not attached to the track in anyway, and there is no friction from the track or from air resistance. If the radius of the loop is *R* = 6.0 m, what is the minimum height *h* for which the roller coaster will not fall off the track at the top of the loop?



470) _____

A) 15 m B) 18 m C) 8.5 m D) 21 m E) 12 m

471) A stone is released from rest at a height *h* at the left side of a loop-the-loop, as shown in the figure. There is no appreciable friction from the track or from air resistance. If the radius of the loop is *R*, what is the minimum height *h* for which the stone will not fall off the track at the top of the loop?



471) _____

A) 3.5 *R* B) 2.5 *R* C) $\sqrt{2}R$ D) 2.0 *R* E) 3.0 *R*

472) A small 1.4-N stone slides down a frictionless bowl, starting from rest at the rim. The bowl itself is a hemisphere of radius 75 cm. Just as the stone reaches the bottom of the bowl, how hard is the bowl pushing on it? 472) _____

A) 0.70 N B) 4.2 N C) 2.8 N D) 1.4 N E) 5.6 N

473) A 30-N stone is dropped from a height of 10 m and strikes the ground with a speed of 13 m/s. What average force of air friction acted on the stone as it fell? 473) _____

A) 4.1 N B) 0.13 kN C) 7.2 N D) 2.9 N E) 1.2 N

474) A 60-kg skier starts from rest from the top of a 50-m high slope. If the work done by friction is -6.0 kJ, what is the speed of the skier on reaching the bottom of the slope? 474) _____

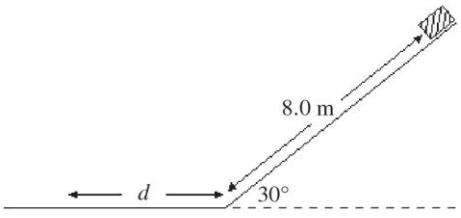
A) 24 m/s B) 28 m/s C) 31 m/s D) 17 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

475) A 7.5-kg otter slides down a hill, starting from rest at the top. The sloping surface of the hill is 8.8 m long, and the top is 6.5 m above the base. If the speed of the otter at the bottom of the hill is 9.2 m/s, how much energy was lost to nonconservative forces on the hill? 475) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

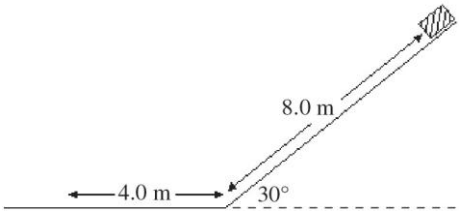
476) An object with a mass of 10 kg is initially at rest at the top of a frictionless inclined plane that rises at 30° above the horizontal. At the top, the object is initially 8.0 m from the bottom of the incline, as shown in the figure. When the object is released from this position, it eventually stops at a distance *d* from the bottom of the inclined plane along a horizontal surface, as shown. The coefficient of kinetic friction between the horizontal surface and the object is 0.20, and air resistance is negligible. Find the distance *d*.



476) _____

A) 5.0 m B) 15 m C) 25 m D) 20 m E) 10 m

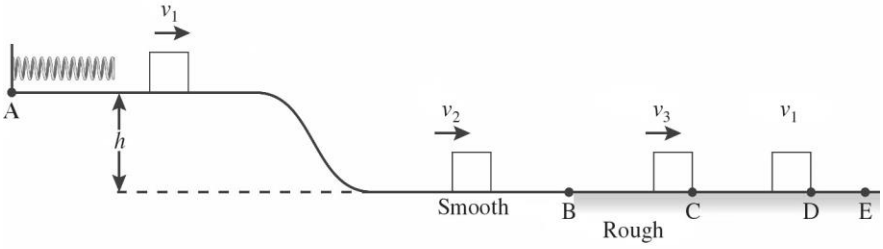
477) On a planet where $g = 10.0$ m/s^2 and air resistance is negligible, a sled is at rest on a rough inclined hill rising at 30° as shown in the figure. The object is allowed to move and it stops on a rough horizontal surface, at a distance of 4.0 m from the bottom of the hill. The coefficient of kinetic friction on the hill is 0.40. What is the coefficient of kinetic friction between the horizontal surface and the sled?



477) _____

A) 0.20 B) 0.10 C) 0.31 D) 0.40 E) 0.60

478) A 0.12-kg block is held in place against the spring by a 35-N horizontal external force. The external force is removed, and the block is projected with a velocity $v_1 = 1.2$ m/s when it separates from the spring, as shown in the figure. The block descends a ramp and has a velocity $v_2 = 1.4$ m/s at the bottom of the ramp. The track is frictionless between points A and B. The block enters a rough section at B, extending to E. The coefficient of kinetic friction between the block and the rough surface is 0.26. The block moves on to D, where it stops. By how many centimeters was the spring initially compressed?

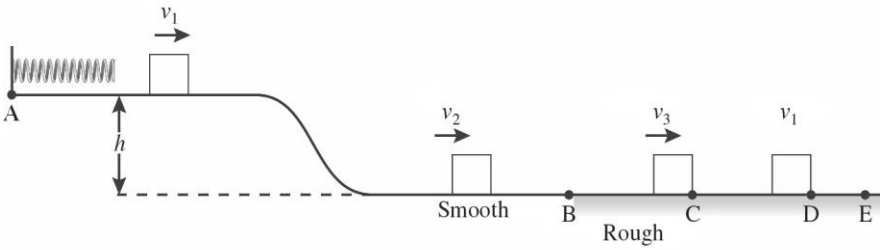


478) _____

A) 0.67 cm B) 0.18 cm C) 0.99 cm D) 0.49 cm E) 0.26 cm

479) As shown in the figure, a 1.45-kg block is held in place against the spring by a 21-N horizontal external force. The external force is removed, and the block is projected with a velocity $v_1 = 1.2$ m/s as it separates from the spring. The block descends a ramp and has a velocity $v_2 = 2.1$ m/s at the bottom. The track is frictionless between points A and B. The block enters a rough section at B, extending to E. The coefficient of kinetic friction between the block and the rough surface is

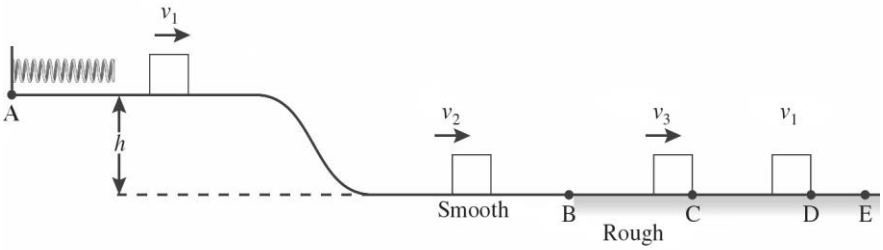
0.29. The velocity of the block is $v_3 = 1.4\ \text{m/s}$ at C. The block moves on to D, where it stops. How much work is done by friction between points B and C?



479) _____

A) -14 J B) -6.4 J C) -3.6 J D) -7.0 J E) -1.8 J

480) A 0.46-kg block is held in place against the spring by a 30-N horizontal external force. The external force is removed, and the block is projected with a velocity $v_1 = 1.2\ \text{m/s}$ upon separation from the spring, as shown in the figure. The block descends a ramp and has a velocity $v_2 = 1.5\ \text{m/s}$ at the bottom. The track is frictionless between points A and B. The block enters a rough section at point B, extending to E. The coefficient of kinetic friction between the block and the rough surface is 0.38. The velocity of the block is $v_3 = 1.4\ \text{m/s}$ at point C. The block moves on to D, where it stops. What distance does the block travel between points B and D?



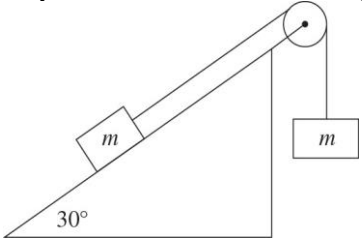
480) _____

A) 0.60 m B) 0.40 m C) 0.30 m D) 0.039 m E) 0.26 m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

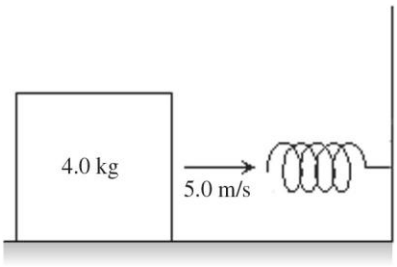
481) A sled is moving along a horizontal surface with a speed of 5.7 m/s. It then slides up a rough hill having a slope of 11° above the horizontal. The coefficient of kinetic friction between the sled and the surface of the hill is 0.26. How far along the surface does the block travel up the incline? 481) _____

482) The figure shows two crates, each of mass m = 24 kg, that are connected by a very light wire. The coefficient of kinetic friction between the crate on the inclined surface and the surface itself is 0.31. Find the speed of the crates after they have moved 1.6 m starting from rest.



482) _____

483) As shown in the figure, a 4.0-kg block is moving at 5.0 m/s along a horizontal frictionless surface toward an ideal spring that is attached to a wall. After the block collides with the spring, the spring is compressed a maximum distance of 0.68 m. What is the speed of the block when the spring is compressed to only one-half of the maximum distance?



483) _____

484) How many joules of energy are used by a 2.0 hp motor that runs for 1.0 hour? (1 hp = 746 W) 484) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

485) 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? 485) _____

A) 17 W B) 22 W C) 21 W D) 26 W

486) How many joules of energy are used by a 1.0-hp motor that runs for 1.0 hour? (1 hp = 746 W) 486) _____

A) 2.7 MJ B) 4.8 J C) 45 kJ D) 3.6 kJ

487) A 1500-kg car accelerates from rest to 25 m/s in 7.0 s. What is the average power delivered by the engine? (1 hp = 746 W) 487) _____

A) 60 hp B) 70 hp C) 90 hp D) 80 hp

488) At what minimum rate is a 60.0-kg boy using energy when, in 8.00 s, he runs up a flight of stairs that is 10.0-m high? 488) _____

A) 75.0 W B) 735 W C) 48.0 W D) 4.80 kW

489) If electricity costs 7.06¢/kW·h, how much would it cost you to run a 120–W stereo system $4.0\,\text{hours}$ per day for $4.0\,\text{weeks}$? 489) _____

A) \$2.66 B) \$0.95 C) \$0.14 D) \$1.62

490) A 1321-kg car climbs a 5.0° slope at a constant speed of $80.0\,\text{km/h}$. Assuming that air resistance may be neglected, at what rate (in kW) must the engine deliver energy to the drive wheels of the car? 490) _____

A) 38 kW B) 287 kW C) 25 kW D) 48 kW

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

491) A typical incandescent light bulb consumes 75 W of power and has a mass of 30 g. You want to save electrical energy by dropping the bulb from a height great enough so that the kinetic energy of the bulb when it reaches the floor will be the same as the energy it took to keep the bulb on for 1.0 hour. From what height should you drop the bulb, assuming no air resistance and constant g? 491) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

492) What is the net power needed to change the speed of a 1600-kg sport utility vehicle from 15.0 m/s to 40.0 m/s in 4.00 seconds? 492) _____

A) 275 kW B) 140 kW C) 14.0 kW D) 100 kW E) 10.0 kW

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

493) Water flows over a waterfall that is 20 m high at the rate of 4.0×10^4 kg/s. If this water powers an electric generator with a 40% efficiency, how many watts of electric power can be supplied? 493) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

494) A certain battery charger uses 12 W of power. At 6.0 cents per kilowatt-hour, how much does it cost to charge batteries for a full day? 494) _____

A) 1.4¢ B) 1.7¢ C) 28¢ D) 2.3¢ E) 75¢

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

495) A family goes on vacation for one week but forgets to turn off an electric fan that consumes electricity at the rate of 200 W. If the cost of electricity is 12.0¢/kW·h how much does it cost (to the nearest penny) to run the fan for the week? 495) _____

496) Suppose you left five 100-W light bulbs burning in the basement for two weeks. If electricity costs 10.0¢/kW·h, (a) how much did the electricity cost (to the nearest dollar) to leave those bulbs on, and (b) how many joules of electrical energy did they consume? 496) _____

497) Rita raises a 10kg package to a height of 2.5 m in 2.0 s.
(a) How much work did she do on the package?
(b) How much power was expended on the package?
(c) If she were to raise the package in 1.0 s rather than 2.0 s, how do the work and power change? 497) _____

498) In a physical fitness program, a woman who weighs 510 N runs up four flights of stairs in 22 s. Each flight rises 3.1 m. (1 hp = 746 W)
(a) What is her total change in potential energy?
(b) What was the minimum average power (in watts) that she expended during the 22 s?
(c) What horsepower motor would be required to generate the same power? 498) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

499) A sand mover at a quarry lifts 2,000 kg of sand per minute a vertical distance of 12 m. The sand is initially at rest and is discharged at the top of the sand mover with speed 5.0 m/s into a loading chute. What minimum power must be supplied to this machine? 499) _____

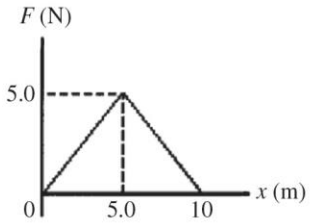
A) 3.9 kW B) 1.1 kW C) 4.3 kW D) 520 W E) 6.7 kW

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

500) A 100%-efficient engine is being used to raise a 89-kg crate vertically upward at a steady rate. If the power output of the engine is 1620 W, how long does it take the engine to lift the crate a vertical distance of 18.7 m? Friction in the system is negligible. 500) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

501) The net force that an animal exerts on a large fruit it has found is observed over a 10-s interval and is shown in the graph in the figure. What was the average power delivered to the fruit by the animal over this time interval?



501) _____

A) 5.0 W B) 0.00 W C) 2.5 W D) 2.2 W E) 1.3 W

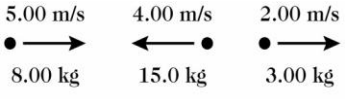
CLO6 Linear momentum

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
502) What is the magnitude of the momentum of a 0.140 kg baseball traveling at 45.0 m/s?502) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
503) A 0.14-kg baseball is dropped from rest from a height of 2.0 m above the ground. What is the magnitude of its momentum just before it hits the ground if we neglect air resistance? 503) _____

A) 1.4 kg · m/s
B) 0.28 kg · m/s
C) 0.88 kg · m/s
D) 0.62 kg · m/s
E) 0.44 kg · m/s

504) Three objects are moving along a straight line as shown in the figure. Taking the positive direction to be to the right, what is the total momentum of this system?



504) _____

A) 0.00 kg · m/s
B) +106 kg · m/s
C) -106 kg · m/s
D) +14.0 kg · m/s
E) -14.0 kg · m/s

505) A 0.330-kg volleyball is thrown vertically downward with a speed of 0.150 m/s in a place where $g = 9.81$ m/s^2. It takes it 0.0655 s to reach the ground. What is the magnitude of its momentum just before it hits the ground? 505) _____

A) 0.0418 kg · m/s
B) 0.212 kg · m/s
C) 0.262 kg · m/s
D) 0.163 kg · m/s
E) 0.0216 kg · m/s

506) Two air track carts move along an air track towards each other. Cart A has a mass of 450 g and moves toward the right with a speed of 0.850 m/s. Cart B has a mass of 300 g and moves toward the left with a speed of 1.12 m/s. What is the total momentum of the two-cart system?506) _____

A) 0.750 kg · m/s toward the left
B) 0.047 kg · m/s toward the right

C) 0.719 kg · m/s toward the right
D) 0.750 kg · m/s toward the right
E) 0.719 kg · m/s toward the left

507) A 100-g ball falls from a window that is 12 m above ground level and experiences no significant air resistance as it falls. What is its momentum when it strikes the ground? 507) _____

A) 1.8 kg · m/s
B) 1.5 kg · m/s
C) 4.8 kg · m/s
D) 2.4 kg · m/s
E) 3.3 kg · m/s

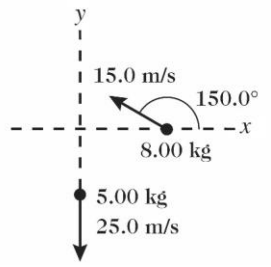
508) A 0.140-kg baseball is dropped and reaches a speed of 1.20 m/s just before it hits the ground and bounces. It rebounds with an upward velocity of 1.00 m/s. What is the change of the ball's momentum during the bounce? 508) _____

A) 0.0280 kg · m/s upwards
B) 0.000 kg · m/s
C) 0.0280 kg · m/s downwards
D) 0.308 kg · m/s downwards
E) 0.308 kg · m/s upwards

509) A firecracker breaks up into two pieces, one of which has a mass of 200 g and flies off along the +*x*-axis with a speed of 82.0 m/s. The second piece has a mass of 300 g and flies off along the +*y*-axis with a speed of 45.0 m/s. What is the total momentum of the two pieces? 509) _____

A) 21.2 kg · m/s at 39.5° from the +*x*-axis
B) 93.5 kg · m/s at 28.8° from the +*x*-axis
C) 361 kg · m/s at 56.3° from the +*x*-axis
D) 21.2 kg · m/s at 56.3° from the +*x*-axis
E) 361 kg · m/s at 0.983° from the +*x*-axis

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
510) Find the magnitude and direction of the net momentum of the system shown in the figure. Express the direction by giving the angle the net momentum makes with the +*x*-axis.



510) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
511) A 600-kg car makes a 90° turn. Its speed before the turn is 21.0 m/s and after the turn it is 24.0 m/s. What is the magnitude of the change in the car's momentum during the turn? 511) _____

A) 12.0×1^{03} kg·m/s
B) 22.2×1^{03} kg·m/s
C) 9.55×1^{03} kg·m/s

D) 10.2×1^{03} kg·m/s

E) 19.1×1^{03} kg·m/s

512) 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? 512) _____

A) 72 kg · m/s
B) 1.8 kg · m/s
C) 1.2 kg · m/s
D) 5.4 kg · m/s
E) 4.4 kg · m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

513) A 60-kg swimmer suddenly dives horizontally from a 150-kg raft with a speed of 1.5 m/s. The raft is initially at rest. What is the speed of the raft immediately after the diver jumps if the water has negligible effect on the raft? 513) _____

514) A 14,000-kg boxcar is coasting at 1.50 m/s along a horizontal track when it suddenly hits and couples with a stationary 10,000-kg boxcar. What is the speed of the cars just after the collision? 514) _____

515) In a police ballistics test, 2.00-g bullet traveling at 700 m/s suddenly hits and becomes embedded in a stationary 5.00-kg wood block. What is the speed of the block immediately after the bullet has stopped moving relative to the block? 515) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

516) A 328-kg car moving at 19.1 m/s in the +*x* direction hits from behind a second car moving at $13.0\ \text{m/s}$ in the same direction. If the second car has a mass of $790\ \text{kg}$ and a speed of $15.1\ \text{m/s}$ right after the collision, what is the velocity of the first car after this sudden collision? 516) _____

A) 14.0 m/s B) -14.0 m/s C) 18.2 m/s D) 24.2 m/s

517) 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? 517) _____

A) 3.80 m/s B) 6.30 m/s C) 4.20 m/s D) 5.70 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

518) An empty train car of mass 2.0×10^4 kg coasts along at 10 m/s. A 3000-kg boulder is suddenly dropped vertically into the car. Find the speed of the car immediately after the boulder is dropped in. 518) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

519) 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? 519) _____

A) 0.28 m/s B) 0.00 m/s C) 0.75 m/s D) 0.50 m/s E) 0.38 m/s

520) A 1200-kg cannon suddenly fires a 100-kg cannonball at $35\ \text{m/s}$. What is the recoil speed of the cannon? Assume that frictional forces are negligible and the cannon is fired horizontally. 520) _____

A) 2.9 m/s B) 35 m/s C) 3.2 m/s D) 3.5 m/s

521) A dinner plate falls vertically to the floor and breaks up into three pieces, which slide horizontally along the floor. Immediately after the impact, a 200-g piece moves along the +*x*-axis with a speed of 2.00 m/s, a 235-g piece moves along the +*y*-axis with a speed of 1.50 m/s. The third piece has a mass of 100 g. What is the speed of the third piece? 521) _____

A) 2.51 m/s B) 5.33 m/s C) 6.83 m/s D) 2.57 m/s E) 3.50 m/s

522) A dinner plate falls vertically to the floor and breaks up into three pieces, which slide horizontally along the floor. Immediately after the impact, a 320-g piece moves along the +*x*-axis with a speed of 2.00 m/s and a 355-g piece moves along the +*y*-axis with a speed of 1.50 m/s. The third piece has a mass of 100 g. In what direction relative to the +*x*-axis does the third piece move? 522) _____

A) 36.9° from the +*x*-axis
B) 216.9° from the +*x*-axis
C) 39.8° from the +*x*-axis
D) 219.8° from the +*x*-axis
E) 39.9° from the +*x*-axis

523) In a police ballistics test, a 10.0-g bullet moving at 300 m/s is fired into a 1.00-kg block at rest. The bullet goes through the block almost instantaneously and emerges with 50.0% of its original speed. What is the speed of the block just after the bullet emerges? 523) _____

A) 3.00 m/s B) 2.97 m/s C) 1.50 m/s D) 273 m/s

524) Two astronauts, of masses 60 kg and 80 kg, are initially right next to each other and at rest in outer space. They suddenly push each other apart. What is their separation after the heavier astronaut has moved 12 m? 524) _____

A) 24 m B) 28 m C) 16 m D) 21 m E) 9.0 m

525) Two astronauts, of masses 60 kg and 80 kg, are initially right next to each other and at rest in outer space. They suddenly push each other apart. How far has the heavier astronaut moved when the lighter astronaut has moved 12 m? 525) _____

A) 21 m B) 7.0 m C) 16 m D) 12 m E) 9.0 m

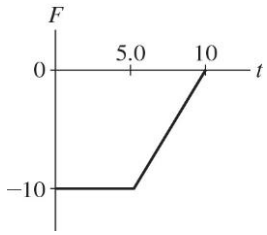
526) Astronaut Jennifer's lifeline to her spaceship comes loose and she finds herself stranded, "floating" 100 m from the mothership. She suddenly throws her 2.00-kg wrench at 20 m/s in a direction away from the ship. If she and her spacesuit have a combined mass of 200 kg, how long does it take her to coast back to her spaceship? 526) _____

A) 500 s B) 1000 s C) 750 s D) 250 s E) 2.50 min

527) A 14-cm diameter champagne bottle rests on its side on top of a frictionless horizontal table. Suddenly, the cork pops and the bottle slides backward, covering a distance of $22.0\ \text{cm}$ in $0.44\ \text{s}$. If the mass of the bottle is 500 times the mass of the cork, find the distance from the original position that the cork will land on the table. Neglect air resistance and assume that the cork is very small compared to the bottle. 527) _____

A) 3000 cm B) 85 m C) 60 m D) 8.5 cm

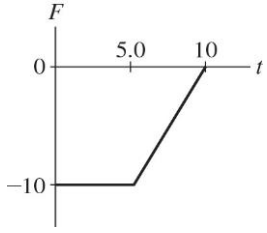
528) The graph in the figure shows the *x* component *F* of the net force that acts for 10 s on a 100-kg crate. What is the change in the momentum of the crate during the 10 s that this force acts?



528) _____

A) 75 kg · m/s
B) 25 kg · m/s
C) -75 kg · m/s
D) -100 kg · m/s
E) -25 kg · m/s

529) A forklift pushes a 100-kg crate, starting from rest, with a horizontal force of magnitude *F*. The graph in the figure shows the *x* component of this force as a function of time. What is the instantaneous velocity of the crate at time *t* = 10 s?



529) _____

A) 25 cm/s B) 75 cm/s C) 0.00 cm/s D) -25 cm/s E) -75 cm/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

530) A batter applies an average force of 8000 N to a baseball for 1.1 ms. What is the magnitude of the impulse delivered to the baseball by the bat? 530) _____

531) A batter hits a 0.140-kg baseball that was approaching him at 30 m/s and, as a result, the ball leaves the bat at 40 m/s in the reverse of its original direction. The ball remains in contact with the bat for 2.0 ms. What is the magnitude of the average force exerted by the bat on the ball? 531) _____

532) Jennifer hits a stationary 0.20-kg ball, and it leaves her racket at 40 m/s. Time-lapse photography shows that the ball was in contact with the racket for 40 ms.
(a) What average force did the ball exert on the racket?
(b) What is the ratio of this force to the weight of the ball? 532) _____

533) A 0.17-kg baseball is thrown with a speed of 38 m/s and it is hit straight back toward the pitcher with a speed of 62 m/s. What is the magnitude of the impulse exerted upon the ball by the bat? 533) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

534) A super dart of mass 20 g, traveling at 350 m/s, strikes a steel plate at an angle of 30° with the plane of the plate, as shown in the figure. It bounces off the plate at the same angle but at a speed of 320 m/s. What is the magnitude of the impulse that the plate gives to the bullet?

534) _____

A) 0.52 N · s B) 0.30 N · s C) 4.3 N · s D) 300 N · s E) 6.7 N · s

535) A golf club exerts an average horizontal force of 1000 N on a 0.045-kg golf ball that is initially at rest on the tee. The club is in contact with the ball for 1.8 ms. What is the speed of the golf ball just as it leaves the tee? 535) _____

A) 45 m/s B) 35 m/s C) 30 m/s D) 50 m/s E) 40 m/s

536) A 0.140-kg baseball is thrown with a velocity of $27.1\ \text{m/s}$. It is struck by the bat with an average force of 5000 N, which results in a velocity of 37.0 m/s in the opposite direction from the original velocity. How long were the bat and ball in contact? 536) _____

A) 1.79×10^{-3} s B) 4.30×10^{-3} s C) 1.28×10^{-2} s D) 3.07×10^{-2} s

537) Calculate the impulse due to a force of $4.5\ \text{N}$ that lasts for $1.4\ \text{s}$. 537) _____
A) 6.9 kg· m/s B) 5.0 kg· m/s C) 6.3 kg· m/s D) 5.7 kg· m/s

538) A girl of mass 55 kg throws a ball of mass 0.80 kg against a wall. The ball strikes the wall horizontally with a speed of $25\ \text{m/s}$, and it bounces back with this same speed. The ball is in contact with the wall $0.050\ \text{s}$. What is the magnitude of the average force exerted on the wall by the ball? 538) _____

A) 27,500 N B) 800 N C) 55,000 N D) 400 N E) 13,750 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
539) A 475-gram ball is traveling horizontally at 12.0 m/s to the left when it is suddenly struck horizontally by a bat, causing it to reverse direction and initially travel at 8.50 m/s to the right. If the bat produced an average force of 1275 N on the ball, for how long (in milliseconds) was it in contact with the ball? 539) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
540) A 0.140 kg baseball is thrown horizontally with a velocity of 28.9 m/s. It is struck with a constant horizontal force that lasts for 1.85 ms, which results in a velocity of 37.0 m/s in the opposite direction. What was the magnitude of the horizontal force? 540) _____

A) 0.613 kN B) 4.99 kN C) 2.80 kN D) 2.19 kN

541) A golf ball of mass 0.050 kg is at rest on the tee. Just after being struck, it has a velocity of 102 m/s. If the club and ball were in contact for $0.81\ \text{ms}$, what is the average force exerted on the ball by the club? 541) _____

A) 7.1 kN B) 5.5 kN C) 4.9 kN D) 6.3 kN

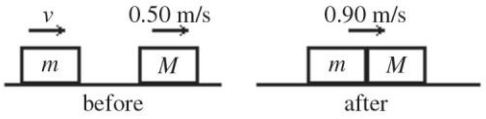
542) A 0.24 kg blob of clay is thrown at a wall with an initial horizontal velocity of $16\ \text{m/s}$. If the clay comes to a stop in $91\ \text{ms}$, what is the average horizontal force on the clay due to the wall? 542) _____

A) 26 N B) 42 N C) 51 N D) 35 N

543) A steady horizontal force lasting for 2.1 s gives a 1.25 kg object an acceleration of 3.2 m/s^2 on a frictionless table. What impulse does this force give to the object? 543) _____

A) 26 kg · m/s B) 8.4 kg · m/s C) 2.6 kg · m/s D) 11 kg · m/s

544) A block of mass m = 34 kg and speed V is behind a block of mass M = 81 kg and speed of $0.50\ m/s$, as shown in the figure. The surface is frictionless and the blocks collide and couple. After the collision, the blocks have a common speed of $0.90\ m/s$. What is the magnitude of the impulse on the 34-kg block due to the collision?



544) _____

A) 73 N · s B) 14 N · s C) 32 N · s D) 57 N · s E) 41 N · s

545) A very small 51-g steel ball is released from rest and falls vertically onto a steel plate. The ball strikes the plate and is in contact with it for 0.50 ms. The ball rebounds elastically and returns to its original height. The total time interval for a round trip is 3.00 s. What is the magnitude of the average force exerted on the ball by the plate during contact with the plate? 545) _____

A) 2000 N B) 1500 N C) 2490 N D) 3500 N E) 3000 N

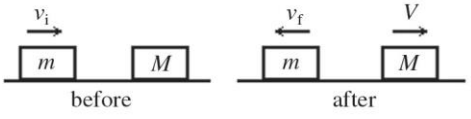
546) A 0.140-kg baseball is dropped from rest. It has a speed of 1.20 m/s just before it hits the ground, and it rebounds with an upward speed of 1.00 m/s. The ball is in contact with the ground for 0.0140 s. What is the average force exerted by the ground on the ball during the time of contact? 546) _____

A) 22.0 N upwards
B) 2.00 N downwards
C) 2.00 N upwards
D) 22.0 N downwards
E) 0.00 N

547) A batter hits a foul ball. The 0.14-kg baseball that was approaching him at 40 m/s leaves the bat at 30 m/s in a direction perpendicular to the line between the batter and the pitcher. What is the magnitude of the impulse delivered to the baseball? 547) _____

A) 5.6 N · s B) 3.5 N · s C) 7.0 N · s D) 9.8 N · s E) 1.4 N · s

548) A block of mass m = 5.6 kg, moving on a frictionless surface with a velocity of $v_i = 6.5\ m/s$ to the right, collides with a block of mass M at rest, as shown in the figure. After the collision, the 5.6-kg block recoils with a velocity of $v_f = 0.70\ m/s$ to the left. If the blocks are in contact for 0.20 s, what is the magnitude of the average force on the 5.6-kg block, while the two blocks are in contact?



548) _____

A) 0 N B) 0 N C) 202 N D) 192 N E) 182 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

549) A force of 5.3 N is needed to hold on to an umbrella in a strong wind. If the air molecules each have a mass of 4.7

$\times 10^{-26}$ kg, and each one strikes the umbrella (without rebounding) with a speed of 2.0 m/s in the same direction, how many atoms strike the umbrella each second? Assume that the wind blows horizontally so that the gravity can be neglected. 549) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

550) A fire hose is turned on the door of a burning building in order to knock the door down. This requires a force of 1000 N. If the hose delivers 40 kg of water per second, what is the minimum velocity of the stream needed to knock down the door, assuming the water doesn't bounce back? 550) _____

A) 25 m/s B) 20 m/s C) 30 m/s D) 15 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

551) A 2200-kg auto moving northward at 12.0 m/s runs into a 3800-kg truck which is also moving northward, but at 5.00 m/s. If the vehicles lock bumpers, how fast are they moving just after the collision? 551) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

552) 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? 552) _____

A) 12.1 m/s B) 8.6 m/s C) 5.5 m/s D) 6.9 m/s

553) A 1000-kg whale swims horizontally to the right at a speed of 6.0 m/s. It suddenly collides directly with a stationary seal of mass 200 kg. The seal grabs onto the whale and holds fast. What is the momentum of these two sea creatures just after their collision? You can neglect any drag effects of the water during the collision. 553) _____

A) 7200 kg · m/s
B) 0.00 kg · m/s
C) 6000 kg · m/s
D) 1200 kg · m/s
E) 2000 kg · m/s

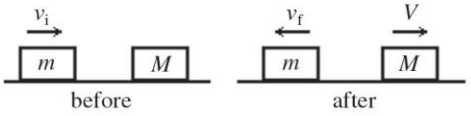
554) A 1000-kg whale swims horizontally to the right at a speed of 6.0 m/s. It suddenly collides directly with a stationary seal of mass 200 kg. The seal grabs onto the whale and holds fast. What is the speed of these two sea creatures just after their collision? You can neglect any drag effects of the water during the collision. 554) _____

A) 5.0 m/s B) 0.00 m/s C) 4.0 m/s D) 6.0 m/s E) 3.0 m/s

555) A 2.0-kg mass moving at 5.0 m/s suddenly collides head-on with a 3.0-kg mass at rest. If the collision is *perfectly inelastic*, what is the speed of the masses just after the collision? 555) _____

A) 2.0 m/s B) 10 m/s
C) 2.5 m/s D) 0 m/s, since the collision is inelastic

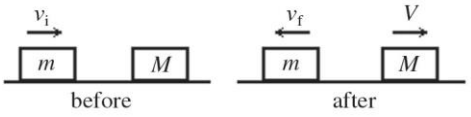
556) A block of mass $m = 4.4$ kg, moving on frictionless surface with a speed $v_i = 9.2\ \text{m/s}$, makes a sudden perfectly elastic collision with a second block of mass M, as shown in the figure. The second block is originally at rest. Just after the collision, the 4.4-kg block recoils with a speed of $v_f = 2.5\ \text{m/s}$. What is the mass M of the second block?



556) _____

A) 0 kg B) 0 kg C) 0 kg D) 0 kg E) 7.7 kg

557) A block of mass m = 3.6 kg, moving on a frictionless surface with a speed $v_i = 9.3\ m/s$, makes a sudden perfectly elastic collision with a stationary block of mass M, as shown in the figure. Just after the collision, the 3.6-kg block recoils with a speed of $v_f = 2.7\ m/s$. What is the speed V of the other block?



557) _____

A) 12.0 m/s B) 8.0 m/s C) 6.6 m/s D) 9.3 m/s E) 10.7 m/s

558) A 320-g air track cart traveling at 1.25 m/s suddenly collides elastically with a stationary 270-g cart. What is the speed of the 270-g cart just after the collision? 558) _____

A) 1.36 m/s B) 0.106 m/s C) 1.14 m/s D) 0.678 m/s E) 2.72 m/s

559) A 320-g air track cart traveling at 1.25 m/s suddenly collides elastically with a stationary 270-g cart. What is the speed of the 320-g cart just after the collision? 559) _____

A) 0.21 m/s B) 1.4 m/s C) 0.68 m/s D) 0.11 m/s E) 1.1 m/s

560) A 550-g ball traveling at 8.0 m/s undergoes a sudden head-on elastic collision with a 250-g ball traveling toward it also at 8.0 m/s. What is the speed of the 250-g mass just after the collision? 560) _____

A) 14 m/s B) 15 m/s C) 0 m/s D) 8.0 m/s E) 4.0 m/s

561) A 340-g air track cart traveling at 1.25 m/s suddenly collides elastically with a stationary 300-g cart. What is the speed of the 300-g cart just after the collision? 561) _____

A) 1.25 m/s B) 0.0781 m/s C) 0.664 m/s D) 1.33 m/s E) 0.625 m/s

562) A proton of mass m is at rest when it is suddenly struck head-on by an alpha particle (which consists of 2 protons and 2 neutrons) moving at speed v. If the collision is perfectly elastic, what speed will the alpha particle have after the collision? (Assume the neutron's mass is equal to the proton's mass.) 562) _____

A) zero B) $3v/5$ C) $5v/3$ D) $2v/3$

563) A 50-g ball moving at 10 m/s in the $+x$ direction suddenly collides head-on with a stationary ball of mass 100 g. If the collision is perfectly elastic, what is the velocity of each ball immediately after the collision? 563) _____

A) -6.7 m/s, +3.3 m/s B) -3.3 m/s, +6.7 m/s
C) +3.3 m/s, -6.7 m/s D) +6.7 m/s, -3.3 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

564) In a perfectly elastic collision, a 400-g ball moving toward the east at 3.7 m/s suddenly collides head-on with a 200 g ball sitting at rest.
(a) Determine the velocity of the first ball just after the collision.
(b) Determine the velocity of the second ball just after the collision.
(c) Is kinetic energy conserved in this collision? How do you know? 564) _____

565) An 80-kg man is skating northward and happens to suddenly collide with a 20-kg boy who is ice skating toward the

east. Immediately after the collision, the man and boy are seen to be moving together at 2.5 m/s in a direction 60° north of east. How fast was the boy moving just before the collision? 565) _____

566) A car (of mass 1500 kg) and a small truck (of mass 2000 kg) collide suddenly at right angles at an icy intersection. The car was originally traveling eastward at 20.0 m/s and the truck was traveling northward at 20.0 m/s just before the collision took place. What is the speed of the combined wreck just after the collision if the vehicles become enmeshed?
566) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

567) Two vehicles approach a right angle intersection and then suddenly collide. After the collision, they become entangled. If their mass ratios were 1:4 and their respective speeds as they approached the intersection were both 13 m/s, find the magnitude and direction of the final velocity of the wreck. 567) _____

A) 26 m/s at 76° with respect to the original direction of the lighter car
B) 16 m/s at 76° with respect to the original direction of the lighter car
C) 16 m/s at 14° with respect to the original direction of the lighter car
D) 11 m/s at 14° with respect to the original direction of the lighter car
E) 11 m/s at 76° with respect to the original direction of the lighter car

568) A car heading north suddenly collides at an intersection with a truck of the same mass heading east. If they lock together and travel at $28\ \text{m/s}$ at 15° north of east just after the collision, how fast was the car initially traveling? 568) _____

A) 14 m/s B) 11 m/s C) 28 m/s D) 7 m/s

569) A puck with a mass m_1 = 50 g moving at 1.0 m/s approaches a stationary puck with a mass m_2 = 100 g on a frictionless air table, and they undergo a sudden two-dimensional elastic collision. After the collision, both pucks have identical speeds, but travel in different directions. What is the angle between the original and final paths of puck with mass m_1? 569) _____

A) 90° B) 150° C) 60° D) 120° E) 30°

570) A 900-kg car traveling east at 15.0 m/s suddenly collides with a 750-kg car traveling north at 20.0 m/s. The cars stick together after the collision. What is the speed of the wreckage just after the collision? 570) _____

A) 25.0 m/s B) 6.10 m/s C) 12.2 m/s D) 17.3 m/s E) 35.0 m/s

571) A 900-kg car traveling east at 15.0 m/s suddenly collides with a 750-kg car traveling north at 20.0 m/s. The cars stick together after the collision. In what direction does the wreckage move just after the collision? 571) _____

A) 45.0° N of E
B) 48.0° N of E
C) 36.9° N of E
D) 42.0° N of E
E) 53.1° N of E

572) A 900-kg car traveling 30.0° south of east at 12.0 m/s suddenly collides with a 750-kg car traveling north at 17.0 m/s. The cars stick together after colliding. What is the speed of the wreckage just after the collision? 572) _____

A) 20.4 m/s B) 25.0 m/s C) 7.21 m/s D) 12.2 m/s E) 17.3 m/s

573) A 1500-kg car traveling at 90 km/h toward the east suddenly collides with a 3000-kg car traveling at 60 km/h toward the south. The two cars stick together after the collision. What is the speed of the cars after collision? 573) _____

A) 22 m/s B) 14 m/s C) 8.3 m/s D) 17 m/s

574) A 1500-kg car traveling at 90 km/h toward the east suddenly collides with a 3000-kg car traveling at 60 km/h toward the south. The two cars stick together after the collision. What is the direction of motion of the cars after collision? 574) _____

A) 53.1° S of E B) 36.9° E of S C) 36.9° S of E D) 53.1° E of S

575) Two dogs, Rover and Fido, run on a level frictionless surface. Rover runs eastward with a momentum of 24 kg . m/s, and Fido runs northward with momentum 10 kg . m/s. They make a sudden perfectly inelastic collision. What is the magnitude of their combined momentum after the collision? 575) _____

A) 34 kg . m/s
B) 26 kg . m/s
C) 14 kg . m/s
D) It cannot be determined without knowing the masses and velocities of the dogs.

576) A 0.140-kg baseball is dropped from rest from a height of 2.20 m above the ground and experiences negligible air resistance as it falls. It rebounds to a height of 1.60 m. What change in the ball's momentum occurs as it rebounds from the ground? 576) _____

A) 0.350 kg · m/s upwards
B) 1.70 kg · m/s upwards
C) 0.350 kg · m/s downwards
D) 0.117 kg · m/s downwards
E) 0.117 kg · m/s upwards

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

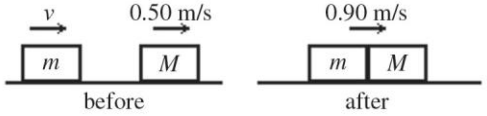
577) A 0.32-kg ball is moving horizontally at 30 m/s just before suddenly bouncing off a wall Just after the bounce, it is moving horizontally at 25 m/s but in the opposite direction.
(a) What is the magnitude of the change in momentum of the ball during the bounce?
(b) What percentage of the ball's original kinetic energy was lost in the collision? 577) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

578) In a police ballistics test, a 2.00-g bullet suddenly hits and becomes embedded in a 5.00-kg wood block which is hanging from a 1.20-m long string. This causes the block to swing through an arc of 3.50°. What was the speed of the bullet just before it hit the block? 578) _____

A) 25.3 m/s B) 16.7 m/s C) 789 m/s D) 262 m/s E) 524 m/s

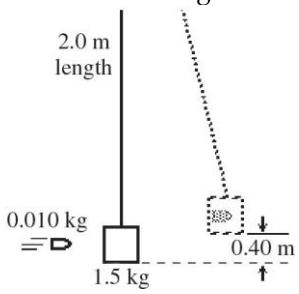
579) A block of mass m = 9.0 kg and speed V and is behind a block of mass M = 27 kg and speed of 0.50 m/s as shown int the figure. The surface is frictionless, and the blocks suddenly collide and couple. After the collision, the blocks have a common speed of 0.90 m/s. How much kinetic energy of the blocks is lost due to the collision?



579) _____

A) 2.0 J B) 11 J C) 31 J D) 8.6 J E) 4.6 J

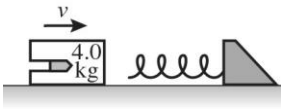
580) As shown in the figure, a bullet of mass 0.010 kg moving horizontally suddenly strikes a block of wood of mass 1.5 kg that is suspended as a pendulum. The bullet lodges in the wood, and together they swing upward a vertical distance of 0.40 m. The length of the string is 2.0 m. What was the speed of the bullet just before it struck the wooden block?



580) _____

A) 250 m/s B) 370 m/s C) 67 m/s D) 650 m/s E) 420 m/s

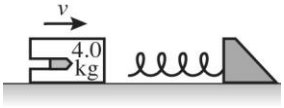
581) An 8.0-g bullet is suddenly shot into a 4.0-kg block that is at rest on a frictionless horizontal surface, as shown in the figure. The bullet remains lodged in the block. The block then moves against a spring and compresses it by 3.7 cm. The force constant (spring constant) of the spring is $2500\ \text{N/m}$. What was the initial speed v of the bullet?



581) _____

A) 520 m/s B) 500 m/s C) 480 m/s D) 440 m/s E) 460 m/s

582) An 8.0-g bullet is suddenly shot into a 4.0-kg block, at rest on a frictionless horizontal surface, as shown in the figure. The bullet remains lodged in the block. The block then moves against a spring and compresses it by 8.9 cm. The force constant (spring constant) of the spring is $1400\ \text{N/m}$. What is the magnitude of the impulse on the block (including the bullet inside) due to the spring during the entire time interval during which the block compresses the spring?



582) _____

A) 13 N · s B) 12 N · s C) 8.3 N · s D) 6.7 N · s E) 10 N · s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

583) In a police rifle test, a 15-g bullet traveling 213 m/s in a vertical direction suddenly buries itself in a 2.4-kg block of wood at rest directly above it. As a result, the bullet-block combination moves vertically upward.
(a) Determine the velocity of the bullet-block combination just after the impact.
(b) Determine the maximum height reached by the bullet/block combination.
(c) Is kinetic energy conserved in this collision? 583) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

584) In a certain nuclear reactor, neutrons suddenly collide with deuterons, which have twice the mass of neutrons. In a head-on elastic collision with a stationary deuteron, what fraction of the initial kinetic energy of a neutron is transferred to the deuteron? 584) _____

A) 8/9 B) 5/6 C) 1/3 D) 1/2 E) 3/4

585) In a certain nuclear reactor, neutrons suddenly collide with carbon nuclei, which have 12 times the mass of neutrons. In a head-on elastic collision with a stationary carbon nucleus, what fraction of its initial speed does the neutron have after the collision? 585) _____

A) 11/13 B) 5/6 C) 1/12 D) 11/12 E) 10/13

586) An object initially at rest suddenly explodes in two fragments of masses $2.6\,\text{kg}$ and $3.3\,\text{kg}$ that move in opposite directions. If the speed of the first fragment is $3.6\,\text{m/s}$, find the internal energy of the explosion. 586) _____

A) 38 kJ B) 38 J C) 30 kJ D) 30 J

587) Two simple pendulums of equal length l = 0.45 m are suspended from the same point. The pendulum bobs are small solid steel spheres. The first bob is drawn back to make a 35° angle with the vertical, while the other one is left hanging at rest. If the first bob has a mass of 0.25 kg and the second has a mass of $0.54\,\text{kg}$, how high will the second bob rise above its initial position when struck elastically by the first bob after it is released? 587) _____

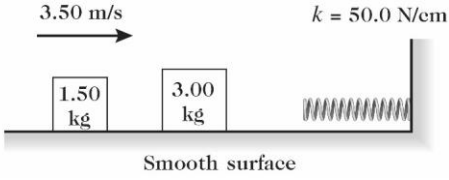
A) 3.9 cm B) 4.4 cm C) 3.3 cm D) 2.7 cm

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

588) On a frictionless horizontal surface, a 1.50-kg mass traveling at 3.50 m/s suddenly collides with and sticks to a 3.00-kg mass that is initially at rest, as shown in the figure. This system then runs into an ideal spring of force constant (spring constant) 50.0 N/cm.

(a) What will be the maximum compression distance of the spring?

(b) How much mechanical energy is lost during this process? During which parts of the process (the collision and compression of the spring) is this energy lost?



588) _____

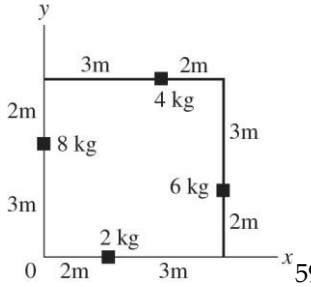
589) A baseball pitcher is employing a ballistic pendulum to determine the speed of his fastball. A 3.3–kg lump of clay is suspended from a cord 2.0 m long. When the pitcher throws his fastball aimed directly at the clay, the ball suddenly becomes embedded in the clay and the two swing up to a maximum height of 0.080 m. If the mass of the baseball is 0.21 kg, find the speed of the pitched ball. 589) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

590) A 1200-kg pick-up truck traveling south at 15 m/s suddenly collides with a 750-kg car that is traveling east. The two vehicles stick together and slide along the road after colliding. A highway patrol officer investigating the accident determines that the final position of the wreckage after the collision is 25 m, at an angle of 50° south of east, from the point of impact. She also determines that the coefficient of kinetic friction between the tires and the road at that location was 0.40. What was the speed of the car just before the collision? 590) _____

A) 14 m/s B) 17 m/s C) 23 m/s D) 20 m/s E) 4.8 m/s

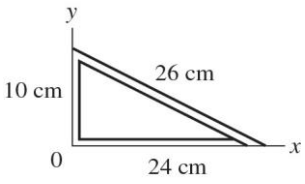
591) In the figure, four point masses are placed as shown. Assume that all the numbers in the figure are accurate to two significant figures. What are the x and y coordinates of the center of mass (or center of gravity) of this arrangement?



591) _____

A) (2.3 m, 2.8 m)
B) (2.3 m, 2.6 m)
C) (2.3 m, 2.7 m)
D) (2.2 m, 2.6 m)
E) (2.2 m, 2.7 m)

592) As shown in the figure, a 60-cm length of uniform wire, of mass 60 g, is bent into a right triangle. What are the x and y coordinates of the center of mass (or center of gravity) of this triangle?



592) _____

A) (8.0 cm, 5.0 cm)
B) (10 cm, 5.0 cm)
C) (10 cm, 3.0 cm)
D) (8.0 cm, 3.0 cm)
E) (9.0 cm, 4.0 cm)

593) A 60.0-kg man stands at one end of a 20.0-kg uniform 10.0-m long board. How far from the man is the center of mass (or center of gravity) of the man-board system? 593) _____

A) 9.00 m B) 2.50 m C) 1.25 m D) 5.00 m E) 7.50 m

594) A 2.0-m rope is lying on a table. You pick up one end and start raising it vertically. How high above the table is the center of mass (or center of gravity) of the rope when half of the rope has lifted off the table? 594) _____

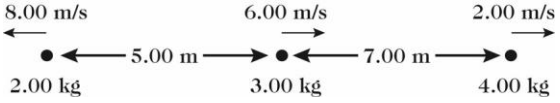
A) 0.25 m B) 1.5 mC) 0.50 m D) 0.75 m E) 1.0 m

595) Three masses are located in the x-y plane as follows: a mass of 6 kg is at (0 m, 0 m), a mass of 4 kg is at (3 m, 0 m), and a mass of 2 kg is at (0 m, 3 m). Where is the center of mass (or center of gravity) of the system? 595) _____

A) (1 m, 1 m)
B) (2 m, 1 m)
C) (1 m, 0.5 m)
D) (1 m, 2 m)
E) (0.5 m, 1 m)

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

596) Three balls are moving along a straight line having the instantaneous positions shown in the figure. At that instant, find the *location* and *velocity* of the center of mass (or center of gravity) of this system.



596) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

597) A 30-kg child stands at one end of a floating 20-kg canoe that is 5.0-m long and initially at rest in the water. The child then slowly walks to the other end of the canoe. How far does the canoe move in the water, assuming water friction is negligible? 597) _____

A) 3.0 m B) 5.0 mC) 2.0 m D) 4.0 m E) 1.0 m

598) The center of mass (or center of gravity) of a two-particle system is at the origin. One particle is located at (3.0 m, 0.0 m) and has a mass of 2.0 kg. The other particle has a mass of 3.0 kg. What is the location of the 3.0-kg particle? 598) _____

A) (2.0 m, 0.0 m) B) (3.0 m, 0.0 m)C) (-3.0 m, 0.0 m) D) (-2.0 m, 0.0 m)

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

599) Three small masses are positioned at the following coordinates: 3.0 kg at (3.0 m, 2.0 m); 4.0 kg at (0.0 m, -1.0 m); and 5.0 kg at (5.0 m, -7.0 m). What are the coordinates of the center of mass (or center of gravity) of this system? 599) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

600) Three small masses are positioned as follows: 2.0 kg at (0.0 m, 0.0 m), 2.0 kg at (2.0 m, 0.0 m), and 4.0 kg at (2.0 m, 1.0 m). Determine the coordinates of the center of mass (or center of gravity) of this system. 600) _____

A) (0.50 m, 1.5 m) B) (2.5 m, 1.5 m)C) (1.5 m, 0.50 m) D) (2.5 m, 0.50 m)

601) Three masses, 1.0 kg, 2.0 kg, and 3.0 kg, are located at (0.0 m, 0.0 m), (1.0 m, 1.0 m), and (2.0 m, -2.0 m), respectively. What is the location of the center of mass (or center of gravity) of this system? 601) _____

A) (-1.3 m, -0.67 m) B) (1.3 m, -0.67 m)
C) (-1.3 m, 0.67 m) D) (1.3 m, 0.67 m)

602) A 3.0-kg mass is located at (0.0 m, 8.0 m), and a 1.0-kg mass is located at (12 m, 0.0 m). You want to add a 4.0-kg mass so that the center of mass (or center of gravity) of the three-mass system will be at the origin. What should be the coordinates of the 4.0-kg mass? 602) _____

A) (3.0 m, 6.0 m) B) (-3.0 m, -6.0 m) C) (-6.0 m, -3.0 m) D) (-12 m, -8.0 m)

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

603) A 1.0-g bead is at (-2.0 cm, 2.0 cm), a 2.0-g bead is at (2.0 cm, -4.0 cm), and a 3.0-g bead is at (2.0 cm, 0.0 cm). What are the coordinates of the center of mass (or center of gravity) of this system of beads? 603) _____

604) Consider the sun and its largest planet Jupiter. On the line joining them, how far from the center of the sun is their center mass? Is it within or outside the sun? (Jupiter-sun distance is 778×10^6 km, diameter of the sun is 1.4×10^6 km, the sun is 1000 times as massive as Jupiter) 604) _____

CLO7 Rotational motion & CLO8 Rotational dynamics

605) The diameter of the Moon is 3.47×10^6 m, and it subtends an angle of 0.00904 rad when viewed from the surface of Earth. How far is the Moon from Earth? 605) _____

606) The sun subtends an angle of 0.00928 rad when viewed from the surface of the earth, and its distance from Earth is 1.5×10^{11} m. What is the diameter of the sun? 606) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

607) What is the angular speed, in rad/s, of a flywheel turning at 813.0 rpm? 607) _____
A) 63.84 rad/s B) 95.33 rad/s C) 85.14 rad/s D) 13.53 rad/s

608) Through how many degrees does a 33 rpm turntable rotate in 0.32 s? 608) _____
A) 74° B) 46° C) 35° D) 63°

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
609) Express the angular speed of an old 33 1/3 rpm LP in rad/s. 609) _____

610) An artificial satellite in a low orbit circles the earth every 98 minutes. What is its angular speed in rad/s? 610) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
611) A chicken is running in a circular path with an angular speed of 1.52 rad/s. How long does it take the chicken to complete one revolution? 611) _____

A) 2.07 s B) 8.26 s C) 4.77 s D) 118 sE) 4.13 s

612) At a certain instant, a compact disc is rotating at 210 rpm. What is its angular speed in rad/s? 612) _____
A) 22 rad/s B) 11 rad/s C) 660 rad/s D) 69 rad/s E) 45 rad/s

613) When a fan is turned off, its angular speed decreases from 10 rad/s to 6.3 rad/s in 5.0 s. What is the magnitude of the average angular acceleration of the fan? 613) _____

A) 0.74 rad/s^2
B) 11 rad/s^2
C) 0.86 rad/s^2
D) 0.37 rad/s^2
E) 1.2 rad/s^2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
614) A bicycle wheel has an outside diameter of 66 cm. Through what distance does a point on the rim move as the wheel rotates through an angle of 70°? 614) _____

615) When Mary is 3.00 m from the center of a merry-go-round, her tangential speed is a constant 1.88 m/s.
(a) What is her angular speed in rad/s?
(b) What is the magnitude of her linear acceleration? 615) _____

616) A cylinder of radius 8.0 cm rolls 20 cm in 5.0 s without slipping. Through how many degrees does the cylinder turn during this time? 616) _____

617) A wheel of diameter 0.70 m rolls on the floor without slipping. A point at the top of the wheel moves with a speed 2.0 m/s relative to the floor.
(a) At what speed is the central axis of the wheel moving relative to the floor?
(b) What is the angular speed of the wheel? 617) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
618) A child is riding a merry-go-round that is turning at 7.18 rpm. If the child is standing 4.65 m from the center of the merry-go-round, how fast is the child moving? 618) _____

A) 1.75 m/s B) 1.80 m/s C) 3.50 m/s D) 5.64 m/s E) 0.556 m/s

619) An electrical motor spins at a constant $2695.0\ \text{rpm}$. If the rotor radius is $7.165\ \text{cm}$, what is the linear acceleration of the edge of the rotor? 619) _____

A) 5707 m/s^2 B) 28.20 m/s^2 C) 572,400 m/s^2 D) 281.6 m/s^2

620) A string is wound tightly around a fixed pulley having a radius of 5.0 cm. As the string is pulled, the pulley rotates without any slipping of the string. What is the angular speed of the pulley when the string is moving at 5.0 m/s? 620) _____

A) 25 rad/s B) 50 rad/s C) 10 rad/s D) 100 rad/s E) 20 rad/s

621) A scooter has wheels with a diameter of 120 mm. What is the angular speed of the wheels when the scooter is moving forward at 6.00 m/s? 621) _____

A) 47.7 rpm B) 50.0 rpm C) 100 rpm D) 72.0 rpm E) 955 rpm

622) A bicycle has wheels that are 60 cm in diameter. What is the angular speed of these wheels when it is moving at 4.0 m/s? 622) _____

A) 4.8 rad/s B) 7.6 rad/s C) 0.36 rad/s D) 13 rad/s E) 1.2 rad/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

623) A bowling ball of mass 7.5 kg and diameter 18 cm rolls without slipping down a 10-m bowling lane with a constant speed 4.3 m/s.
(a) Through what angle does the bowling ball turn as it travels the length of the lane?
(b) What is the angular speed of the bowling ball?
(c) Calculate the *maximum* radial acceleration that a point on the surface of the bowling ball could have.
(d) Calculate the tangential acceleration of a point on the surface of the bowling ball. 623) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

624) A rolling wheel of diameter of 68 cm slows down uniformly from 8.4 m/s to rest over a distance of 115 m. What is the magnitude of its angular acceleration if there was no slipping? 624) _____

A) 5.7 rad/s^2 B) 0.90 rad/s^2 C) 1.8 rad/s^2 D) 11 rad/s^2

625) A child is riding a merry-go-round that has an instantaneous angular speed of 1.25 rad/s and an angular acceleration of 0.745 rad/s^2. The child is standing 4.65 m from the center of the merry-go-round. What is the magnitude of the linear acceleration of the child? 625) _____

A) 8.05 m/s^2 B) 3.46 m/s^2 C) 4.10 m/s^2 D) 2.58 m/s^2 E) 7.27 m/s^2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

626) When an old LP turntable was revolving at $33\frac{1}{3}$ rpm, it was shut off and uniformly slowed down and stopped in 5.5 seconds.
(a) What was the magnitude of its angular acceleration (in rad/s^2) as it slowed down?
(b) Through how many revolutions did it turn while stopping? 626) _____

627) A wheel accelerates with a constant angular acceleration of 4.5 rad/s^2 from an initial angular speed of 1.0 rad/s. (a)

Through what angle does the wheel turn in the first 2.0 s, and (b) what is its angular speed at that time? 627) _____

628) A wheel starts from rest and has a uniform angular acceleration of 4.0 rad/s^2. After the wheel completes its first revolution, how long does it take for it to make its *second* complete revolution? 628) _____

629) A bicycle wheel has an initial angular speed of 7.2 rad/s. After turning through one-half of a revolution, the angular speed is reduced to 2.2 rad/s. If the angular acceleration of the wheel was constant during the motion, how long will it take the wheel to make the one-half revolution?629) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

630) How long does it take for a rotating object to speed up from 15.0 rad/s to 33.3 rad/s if it has a uniform angular acceleration of 3.45 rad/s^2? 630) _____

A) 10.6 s B) 63.1 s C) 5.30 s D) 4.35 s E) 9.57 s

631) A wheel accelerates from rest to 59 rad/s at a uniform rate of 58 rad/s^2. Through what angle (in radians) did the wheel turn while accelerating? 631) _____

A) 38 rad B) 60 rad C) 30 rad D) 24 rad

632) A machinist turns on the power to a grinding wheel at time $t = 0$ s. The wheel accelerates uniformly from rest for 10 s and reaches the operating angular speed of 38 rad/s. The wheel is run at that angular speed for 30 s and then power is shut off. The wheel slows down uniformly at 2.1 rad/s^2 until the wheel stops. In this situation, what is the angular acceleration of the wheel between $t = 0$ s and $t = 10$ s? 632) _____

A) 5.3 rad/s^2 B) 3.8 rad/s^2 C) 6.1 rad/s^2 D) 4.6 rad/s^2 E) 6.8 rad/s^2

633) A machinist turns on the power on to a grinding wheel at time $t = 0$ s. The wheel accelerates uniformly from rest for 10 s and reaches the operating angular speed of 58 rad/s. The wheel is run at that angular velocity for 30 s, and then power is shut off. The wheel slows down uniformly at 1.4 rad/s^2 until the wheel stops. What is the total number of revolutions made by the wheel in this situation? 633) _____

A) 510 B) 320 C) 280 D) 470 E) 750

634) A machinist turns on the power on to a grinding wheel at time $t = 0$ s. The wheel accelerates uniformly from rest for 10 s and reaches the operating angular speed of 96 rad/s. The wheel is run at that angular velocity for 40 s and then power is shut off. The wheel slows down uniformly at 1.5 rad/s^2 until the wheel stops. For how long a time after the power is shut off does it take the wheel to stop? 634) _____

A) 70 s B) 68 s C) 62 s D) 66 s E) 64 s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

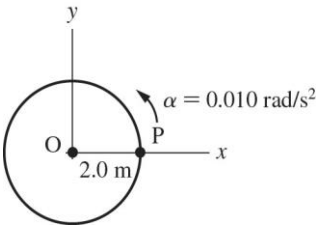
635) In the figure, point P is on the rim of a wheel of radius 2.0 m. At time $t = 0$, the wheel is at rest, and P is on the x-axis. The wheel undergoes a uniform counterclockwise angular acceleration of 0.010 rad/s^2 about the center O.

(a) At time $t = 0$, what is the tangential acceleration of P?

(b) What is the linear speed of P when it reaches the y-axis?

(c) What is the magnitude of the net linear acceleration of P when it reaches the y-axis?

(d) How long after starting does it take for P to return to its original position on the x-axis?



635) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

636) An old LP record that is originally rotating at 33.3 rad/s is given a uniform angular acceleration of 2.15 rad/s^2. Through what angle has the record turned when its angular speed reaches 72.0 rad/s? 636) _____

A) 66.8 rad B) 697 rad C) 316 rad D) 948 rad E) 83.2 rad

637) A wheel rotates through an angle of 13.8 rad as it slows down uniformly from 22.0 rad/s to 13.5 rad/s. What is the magnitude of the angular acceleration of the wheel? 637) _____

A) 5.45 rad/s^2
B) 22.5 rad/s^2
C) 10.9 rad/s^2
D) 0.616 rad/s^2
E) 111 rad/s^2

638) A pulley has an initial angular speed of 12.5 rad/s and a constant angular acceleration of 3.41 rad/s^2. Through what angle does the pulley turn in 5.26 s? 638) _____

A) 160 rad B) 42.6 rad C) 22.6 rad D) 113 rad E) 19.3 rad

639) An old 78 rpm record rotates through an angle of 320° as it slows down uniformly from 78.0 rpm to 22.8 rpm. What is the magnitude of the angular acceleration of the record? 639) _____

A) 8.35 rad/s^2
B) 6.50 rad/s^2
C) 5.46 rad/s^2
D) 10.9 rad/s^2
E) 2.34 rad/s^2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

640) A turntable 45 cm in diameter starts from rest and makes its first complete revolution in 3.4 s with constant angular acceleration. If it maintains the same acceleration, how long will it take the turntable to make its *second* complete revolution? 640) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

641) A Ferris wheel rotating at 20 rad/s slows down with a constant angular acceleration of magnitude 5.0 rad/s^2. How many revolutions does it make while slowing down before coming to rest? 641) _____

A) 20 B) 6.4 C) 40 D) 3.2

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

642) A centrifuge in a medical laboratory rotates at a rotational speed of 3600 rev/min. When switched off, it makes 50

complete turns at a constant angular acceleration before coming to rest.
(a) What was the magnitude of the angular acceleration of the centrifuge as it slowed down?
(d) How long did it take for the centrifuge to come to rest after being turned off? 642) _____

643) A majorette fastens two batons together at their centers to form an X shape. Each baton consists of an extremely light 1.2-m bar with small 0.25-kg balls at each end. What is the moment of inertia of this baton about an axis through the center of the X? 643) _____

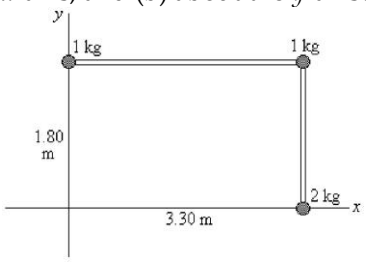
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
644) A triatomic molecule is oriented as follows along the x-axis: mass m is at the origin, mass $2m$ is at $x = a$, and, mass $3m$ is at $x = 2a$. What is the moment of inertia of this molecule about the y-axis? 644) _____

A) $12ma^2$ B) $14ma^2$ C) $3ma^2$ D) $2ma^2$

645) Two uniform solid spheres have the same mass, but one has twice the radius of the other. The ratio of the larger sphere's moment of inertia about a central axis to that of the smaller sphere is 645) _____

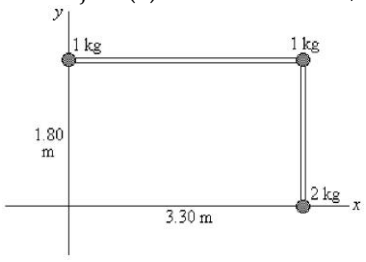
A) 8/5. B) 2. C) 4/5. D) 1/2. E) 4.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
646) The L-shaped object shown in the figure consists of three small masses connected by extremely light rods. Assume that the masses shown are accurate to three significant figures. What is the moment of inertia of this object (a) about the x-axis, and (b) about the y-axis?



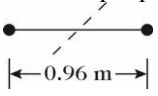
646) _____

647) The L-shaped object shown in the figure consists of three small masses connected by thin uniform rods, each rod of mass 3.00 kg. Assume that the masses shown are accurate to three significant figures. What is the moment of inertia of this object (a) about the x-axis, and (b) about the y-axis?



647) _____

648) In the figure, a weightlifter's barbell consists of two identical small but dense spherical weights, each of mass 50 kg. These weights are connected by a thin 0.96-m rod with a mass of 24 kg. Find the moment of inertia of the barbell through the axis perpendicular to the rod at its center, assuming the two weights are small enough to be treated as point masses.



648) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

649) A potter's wheel has the shape of a solid uniform disk of mass $7.0\,\text{kg}$ and radius 0.65 m. It spins about an axis perpendicular to the disk at its center. A small 2.1 kg lump of very dense clay is dropped onto the wheel at a distance 0.41 m from the axis. What is the moment of inertia of the system about the axis of spin? 649) _____

A) 2.5 kg · m^2 B) 1.8 kg · m^2 C) 1.5 kg · m^2 D) 0.40 kg · m^2

650) A uniform solid cylinder with a radius of 10 cm and a mass of 3.0 kg is rotating about its center with an angular speed of 33.4 rpm. What is its kinetic energy? 650) _____

A) 1.1 J B) 17 J C) 0.96 J D) 0.092 J E) 0.18 J

651) What is the kinetic energy of a 120-cm thin uniform rod with a mass of 450 g that is rotating about its center at 3.60 rad/s? 651) _____

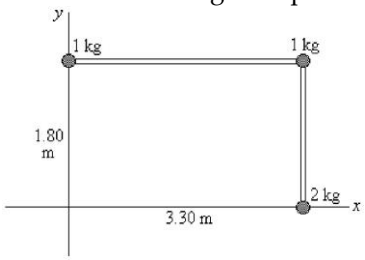
A) 0.350 J B) 0.700 J C) 2.10 J D) 0.960 J E) 4.20 J

652) To drive a typical car at 40 mph on a level road for one hour requires about 3.2 × 10^7 J of energy. Suppose we tried to store this much energy in a spinning, solid, uniform, cylindrical flywheel. A large flywheel cannot be spun too fast or it will fracture. If we used a flywheel of diameter 1.2 m and mass 400 kg, what angular speed would be required to store 3.2 × 10^7 J? 652) _____

A) 530 rad/s B) 3600 rad/s C) 5500 rad/s D) 940 rad/s E) 1800 rad/s

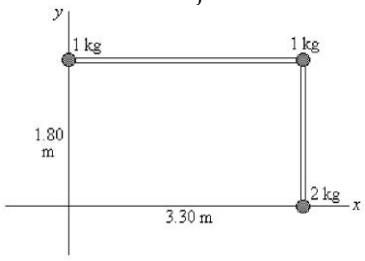
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

653) The L-shaped object shown in the figure consists of three small masses connected by extremely light rods. Assume that the masses shown are accurate to three significant figures. How much work must be done to accelerate the object from rest to an angular speed of 3.25 rad/s (a) about the *x*-axis, (b) about the *y*-axis?



653) _____

654) The L-shaped object shown in the figure consists of three small masses connected by thin uniform rods, each rod of mass 3.00 kg. Assume that the masses shown are accurate to three significant figures. How much work must be done to accelerate the object from rest to an angular speed of 3.25 rad/s about the *y*-axis?



654) _____

655) A futuristic design for a car is to have a large flywheel within the car to store kinetic energy. The flywheel is a solid uniform disk of mass 370 kg with a radius of 0.50 m, and it can rotate up to $200\,\text{rev/s}$. Assuming all of this stored kinetic

energy could be transferred to the linear speed of the 1500-kg car, find the maximum attainable speed of the car. 655) _____

656) A small ball is tied to one end of a light 2.5-m wire, and the other end of the wire is hooked to the ceiling. A person pulls the ball to the side until the wire makes an angle of 35° with the plane of the ceiling and then gently releases it. What is the angular speed of the ball, in rad/s, as it swings through its lowest point? 656) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

657) While spinning down from 500 rpm to rest, a flywheel does $3.9\,\text{kJ}$ of work. This flywheel is in the shape of a solid uniform disk of radius 1.2 m. What is the mass of this flywheel? 657) _____

A) 4.6 kg B) 4.0 kg C) 5.2 kg D) 3.4 kg

658) A solid uniform sphere of mass 120 kg and radius 1.7 m starts from rest and rolls without slipping down an inclined plane of vertical height 5.3 m. What is the angular speed of the sphere at the bottom of the inclined plane? 658) _____

A) 5.1 rad/s B) 8.7 rad/s C) 6.1 rad/s D) 9.7 rad/s

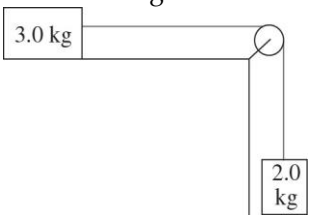
659) A solid uniform disk of diameter 3.20 m and mass 42 kg rolls without slipping to the bottom of a hill, starting from rest. If the angular speed of the disk is 4.27 rad/s at the bottom, how high did it start on the hill? 659) _____

A) 4.28 m B) 2.68 m C) 3.57 m D) 3.14 m

660) A wheel having a moment of inertia of 5.00 kg · m^2 starts from rest and accelerates under a constant torque of 3.00 N · m for 8.00 s. What is the wheel's rotational kinetic energy at the end of 8.00 s? 660) _____

A) 122 J B) 78.8 J C) 64.0 J D) 57.6 J

661) As shown in the figure, two blocks are connected by a light string that passes over a frictionless pulley having a moment of inertia of 0.0040 kg · m^2 and diameter 10 cm. The coefficient of kinetic friction between the table top and the upper block is 0.30. The blocks are released from rest, and the string does not slip on the pulley. How fast is the upper block moving when the lower one has fallen 0.60 m?



661) _____

A) 3.2 m/s B) 5.4 m/s C) 2.0 m/s D) 1.2 m/s E) 1.4 m/s

662) A solid uniform ball with a mass of 125 g is rolling without slipping along the horizontal surface of a table with a speed of 4.5 m/s when it rolls off the edge and falls towards the floor, 1.1 m below. What is the rotational kinetic energy of the ball just before it hits the floor? 662) _____

A) 0.73 J
B) 2.6 J
C) 1.1 J
D) 0.51 J
E) This question cannot be answered without knowing the radius of the ball.

663) A string is wrapped tightly around a fixed pulley that has a moment of inertia of 0.0352 kg · m^2 and a radius of 12.5 cm. A mass of 423 g is attached to the free end of the string. With the string vertical and taut, the mass is gently released so it can descend under the influence of gravity. As the mass descends, the string unwinds and causes the pulley to rotate, but does not slip on the pulley. What is the speed of the mass after it has fallen through 1.25 m? 663) _____

A) 2.28 m/s B) 1.97 m/s C) 3.94 m/s D) 2.00 m/s E) 4.95 m/s

664) A string is wrapped tightly around a fixed frictionless pulley that has a moment of inertia of 0.0352 kg · m^2 and a radius of 12.5 cm. The string is pulled away from the pulley with a constant force of 5.00 N, causing the pulley to rotate. What is the speed of the string after it has unwound 1.25 m if the string does not slip on the pulley? 664) _____

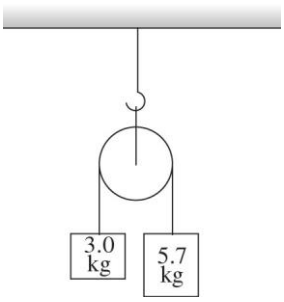
A) 1.18m/s B) 3.18 m/s C) 2.09 m/s D) 2.36 m/s E) 4.95 m/s

665) An Atwood machine consists of a mass of 3.5 kg connected by a light string to a mass of 6.0 kg over a frictionless pulley with a moment of inertia of 0.0352 kg · m^2 and a radius of 12.5 cm. If the system is released from rest, what is the speed of the masses after they have moved through 1.25 m if the string does not slip on the pulley? 665) _____

A) 5.0 m/s B) 2.0 m/s C) 2.3 m/s D) 6.0 m/s E) 4.0 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

666) The figure shows two blocks connected by a light cord over a pulley. This apparatus is known as an Atwood's machine. There is no slipping between the cord and the surface of the pulley. The pulley itself has negligible friction and it has a radius of 0.12 m and a mass of 10.3 kg. We can model this pulley as a solid uniform disk. At the instant that the heavier block has descended 1.5 m starting from rest, what is the speed of the lighter block?



666) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

667) A pencil that is 15.7 cm long is released from a vertical position with the eraser end resting on a table. The eraser does not slip as it tips over. Treat the pencil like a uniform rod. What is the angular speed of the pencil just before it hits the table? 667) _____

A) 16.8 rad/s B) 24.5 rad/s C) 3.70 rad/s D) 7.23 rad/s E) 13.7 rad/s

668) A uniform solid disk is released from rest and rolls without slipping down an inclined plane that makes an angle of 25° with the horizontal. What is the forward speed of the disk after it has rolled 3.0 m, measured along the plane? 668) _____

A) 5.7 m/s B) 2.0 m/s C) 4.1 m/s D) 3.5 m/s E) 6.3 m/s

669) A solid uniform disk is rolling without slipping along a horizontal surface with a speed of 4.5 m/s when it starts up a ramp that makes an angle of 25° with the horizontal. What is the speed of the disk after it has rolled 3.0 m up as measured along the surface of the ramp? 669) _____

A) 1.9 m/s B) 6.8 m/s C) 2.1 m/s D) 8.0 m/s E) 4.0 m/s

670) A solid uniform sphere is rolling without slipping along a horizontal surface with a speed of 5.5 m/s when it starts up a ramp that makes an angle of 25° with the horizontal. What is the speed of the sphere after it has rolled 3.0 m up as measured along the surface of the ramp? 670) _____

A) 4.0 m/s B) 3.5 m/s C) 8.0 m/s D) 2.2 m/s E) 1.9 m/s

671) A hoop is rolling without slipping along a horizontal surface with a forward speed of 5.50 m/s when it starts up a ramp that makes an angle of 25.0° with the horizontal. What is the speed of the hoop after it has rolled 3.00 m up as measured along the surface of the ramp? 671) _____

A) 1.91 m/s B) 2.06 m/s C) 3.79 m/s D) 8.02 m/s E) 4.22 m/s

672) A hoop with a mass of 2.75 kg is rolling without slipping along a horizontal surface with a speed of 4.5 m/s when it starts down a ramp that makes an angle of 25° below the horizontal. What is the forward speed of the hoop after it has rolled 3.0 m down as measured along the surface of the ramp? 672) _____

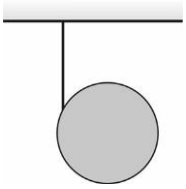
A) 5.7 m/s B) 8.0 m/s C) 5.2 m/s D) 6.3 m/s E) 4.9 m/s

673) A hoop with a mass of 2.75 kg is rolling without slipping along a horizontal surface with a speed of 4.5 m/s when it starts down a ramp that makes an angle of 25° below the horizontal. What is the rotational kinetic energy of the hoop after it has rolled 3.0 m down as measured along the surface of the ramp? 673) _____

A) 45 J
B) 62 J
C) 34 J
D) 22 J
E) This question cannot be answered without knowing the radius of the hoop.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

674) A solid uniform 3.33-kg disk has thin string of negligible mass wrapped around its rim, with one end of the string tied to the ceiling, as shown in the figure. The disk is released from rest, and as it falls, it turns as the string unwraps. At the instant its center has fallen 2.25 m, (a) how fast is the center moving, and (b) how much rotational kinetic energy does the disk have?



674) _____

675) A solid uniform ball of mass 1.0 kg and radius 1.0 cm starts from rest and rolls down a 1.0-m high ramp. There is enough friction on the ramp to prevent the ball from slipping as it rolls down.
(a) What is the forward speed of the ball when it reaches the bottom of the ramp?
(b) What would be the forward speed of the ball if there were no friction on the ramp?
(c) Since the ball starts from the same height in both cases, why is the speed different? 675) _____

676) A solid ball of mass 1.0 kg and radius 10 cm rolls with a forward speed of 10 m/s when it comes to a hill. There is enough friction on the hill to keep the ball from slipping as it rolls up.
(a) How high vertically up the hill can the ball roll before coming to rest?
(b) How high vertically could the ball go if the hill were totally frictionless?
(c) How is it that the ball can go higher *with* friction than without friction? 676) _____

677) A ball in the shape of a uniform spherical shell (like a soccer ball) of mass 1.5 kg and radius 15 cm rolls down a 35° incline that is 6.0 m high, measured vertically. The ball starts from rest, and there is enough friction on the incline to prevent slipping of the ball.
(a) How fast is the ball moving forward when it reaches the bottom of the incline, and what is its angular speed at that instant?
(b) If there were no friction on the incline, how fast would the ball be moving forward and what would be its angular speed at the bottom? 677) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

678) A solid uniform cylinder is rolling without slipping. What fraction of its kinetic energy is rotational? 678) _____

A) 1/4 B) 1/2 C) 3/4 D) 2/3 E) 1/3

679) The lug nuts on a car wheel require tightening to a torque of 90 N · m. If a 30-cm long wrench is used, what is the magnitude of the *minimum* force required using the wrench? 679) _____

A) 30 N B) 150 N C) 15 N D) 300 N

680) A man in a gym is holding an 8.0-kg weight at arm's length, a distance of 0.55 m from his shoulder joint. What is the torque about his shoulder joint due to the weight if his arm is horizontal? 680) _____

A) 0.24 N · m B) 4.4 N · m C) 0 N · m D) 43 N · m E) 15 N · m

681) A man in a gym is holding an 8.0-kg weight at arm's length, a distance of 0.55 m from his shoulder joint. What is the torque about his shoulder joint due to the weight if his arm is held at 30° below the horizontal? 681) _____

A) 2.2 N · m B) 13 N · m C) 22 N · m D) 4.4 N · m E) 37 N · m

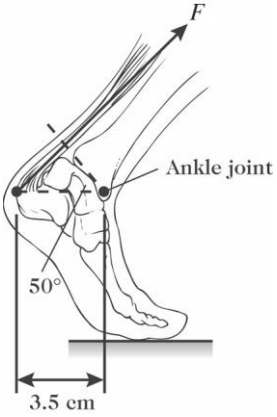
682) A force of 17 N is applied to the end of a 0.63-m long torque wrench at an angle 45° from a line joining the pivot point to the handle. What is the magnitude of the torque about the pivot point produced by this force? 682) _____

A) 7.6 N · m B) 9.7 N · m C) 12.0 N · m D) 10.7 N · m

683) A 95-N force exerted at the end of a 0.32-m long torque wrench produces a torque of 15 N · m. What is the angle (less than 90°) between the wrench handle and the direction of the applied force? 683) _____

A) 30° B) 36° C) 42° D) 24°

684) The figure shows a person's foot. In that figure, the Achilles tendon exerts a force of magnitude $F = 720$ N. What is the magnitude of the torque that this force produces about the ankle joint?



684) _____

A) 26 N · m B) 16 N · m C) 12 N · m D) 21 N · m E) 36 N · m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

685) The drive chain in a bicycle is applying a torque of 0.850 N · m to the wheel of the bicycle. The wheel has a moment of inertia of 0.100 kg · m^2. What is the angular acceleration of the wheel? 685) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

686) The drive chain in a bicycle is applying a torque of 0.850 N · m to the wheel of the bicycle. You can treat the wheel as a thin uniform hoop (or ring) with a mass of 0.750 kg and a radius of 33.0 cm. What is the angular acceleration of the wheel? 686) _____

A) 5.20 rad/s^2
B) 10.4 rad/s^2
C) 3.43 rad/s^2
D) 1.06 rad/s^2
E) 20.8 rad/s^2

687) A mechanic is examining the wheel of a bicycle to adjust the brake. With the bicycle off the ground, he manually rotates the wheel until it reaches an angular speed of 12.0 rad/s and then allows it to coast to a stop. If the wheel has a moment of inertia of 0.100 kg · m^2, and the wheel slows uniformly to a stop in 160 s, what is the magnitude of the retarding torque? 687) _____

A) 1.00 N · m
B) 1.33 N · m
C) 0.0787 N · m
D) 0.00750 N · m
E) 1.67 N · m

688) A force of $16.88\,\text{N}$ is applied tangentially to a wheel of radius 0.340 m and causes an angular acceleration of 1.20 rad/s^2. What is the moment of inertia of the wheel? 688) _____

A) 5.98 kg · m^2 B) 3.59 kg · m^2 C) 4.78 kg · m^2 D) 7.17 kg · m^2

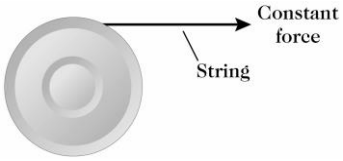
689) A torque of 12 N · m is applied to a solid, uniform disk of radius 0.50 m. If the disk accelerates at $1.6\,\text{rad/s}^2$, what is the mass of the disk? 689) _____

A) 45 kg B) 15 kgC) 30 kg D) 60 kg

690) A particular motor can provide a maximum torque of 110 N · m. Assuming that all of this torque is used to accelerate a solid, uniform, cylindrical flywheel of mass 10.0 kg and radius 3.00 m, how long will it take for the flywheel to accelerate from rest to $8.13\,\text{rad/s?}$ 690) _____

A) 4.03 s B) 3.33 s C) 4.36 s D) 2.83 s

691) The drum shown in the figure has a radius of 0.40 m and a moment of inertia of 2.3 $\text{kg} \cdot \text{m}^2$about an axis perpendicular to it through its center. The frictional torque at the drum axle is 3.0 N · m. A 14-m length of rope is wound around the rim. The drum is initially at rest. A constant force is applied to the free end of the rope until the rope is completely unwound and slips off. At that instant, the angular speed of the drum is $23\,\text{rad/s.}$ The drum then slows down at a constant rate and comes to a halt. In this situation, what was the magnitude of the constant force applied to the rope?



691) _____

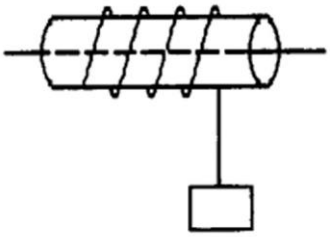
A) 40 N B) 7.5 N C) 18 N D) 29 N E) 51 N

692) In a laboratory experiment, a student brings up the rotational speed of a flywheel to 30.0 rpm. She then allows it to slow down on its own, and counts 240 revolutions before the apparatus uniformly comes to a stop. The moment of inertia of the flywheel is 0.0850 kg · m^2. What is the magnitude of the retarding torque on the flywheel? 692) _____

A) 0.000278 N · m
B) 0.0000136 N · m
C) 0.0425 N · m
D) 0.0787 N · m
E) 0.159 N · m

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

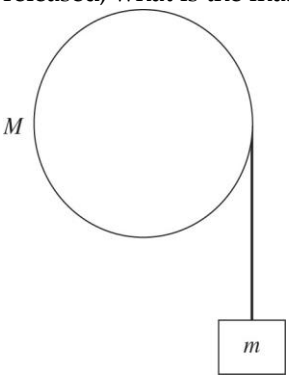
693) A uniform, solid, 100-kg cylinder with a diameter of 1.0 m is mounted so it is free to rotate about fixed, horizontal, frictionless axis that passes through the centers of its circular ends. A 10-kg block is hung from a very light thin cord wrapped around the cylinder's circumference. When the block is released, the cord unwinds and the block accelerates downward, as shown in the figure. What is the acceleration of the block?



693) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

694) A cinder block of mass m = 4.0 kg is hung from a nylon string that is wrapped around a frictionless pulley having the shape of a cylindrical shell, as shown in the figure. If the cinder block accelerates downward at 4.90 m/s^2 when it is released, what is the mass M of the pulley?

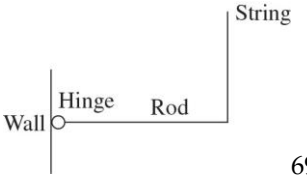


694) _____

A) 10 kg B) 4.0 kg C) 8.0 kg D) 2.0 kg E) 6.0 kg

695) A uniform rod is 2.0 m long. It is hinged to a wall at its left end, and held in a horizontal position at its right end by a vertical very light string, as shown in the figure. What is the angular acceleration of the rod at the moment after the string

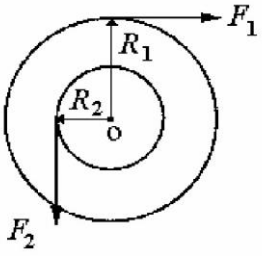
is released if there is no friction in the hinge?



695) _____

A) 3.3 rad/s^2
B) 7.4 rad/s^2
C) 15 rad/s^2
D) 11 rad/s^2
E) It cannot be calculated without knowing the mass of the rod.

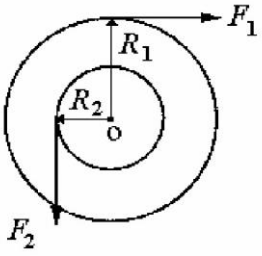
696) A uniform solid cylinder of mass 10 kg can rotate about a frictionless axle through its center O, as shown in the cross-sectional view in the figure. A rope wrapped around the outer radius R_1 = 1.0 m exerts a force of magnitude F_1 = 5.0 N to the right. A second rope wrapped around another section of radius R_2 = 0.50 m exerts a force of magnitude F_2 = 6.0 N downward. What is the angular acceleration of the cylinder?



696) _____

A) 1.0 rad/s^2 B) 0.40 rad/s^2 C) 0.60 rad/s^2 D) 0.80 rad/s^2

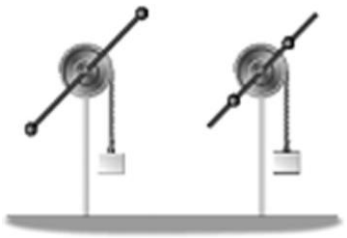
697) A uniform solid cylinder of mass 10 kg can rotate about a frictionless axle through its center O, as shown in the cross-sectional view in the figure. A rope wrapped around the outer radius R_1 = 1.0 m exerts a force of magnitude F_1 = 5.0 N to the right. A second rope wrapped around another section of radius R_2 = 0.50 m exerts a force of magnitude F_2 = 6.0 N downward. How many radians does the cylinder rotate through in the first 5.0 seconds, if it starts from rest?



697) _____

A) 5.0 rad B) 7.5 rad C) 13 rad D) 10 rad

698) The rotating systems shown in the figure differ only in that the two identical movable masses are positioned a distance r from the axis of rotation (left), or a distance $r/2$ from the axis of rotation (right). If you release the hanging blocks simultaneously from rest, and call t_L the time taken by the block on the left and t_R the time taken by the block on the right to reach the bottom, respectively, then



698) _____

A) $t_L = t_R$. B) $t_L > t_R$. C) $t_L < t_R$.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

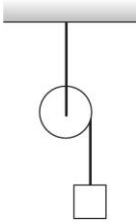
699) A 1.53-kg bucket hangs on a rope wrapped around a pulley of mass 7.07 kg and radius 66 cm. This pulley is frictionless in its axle, and has the shape of a solid uniform disk. After the bucket has been released, (a) what is the angular acceleration of the pulley, and (b) what is the acceleration of the bucket? 699) _____

700) A 350-g air track cart on a horizontal air track is attached to a string that goes over a frictionless pulley with a moment of inertia of 6.00×10^{-6} kg · m^2 and a radius of 1.35 cm. If the string is pulled vertically downward by a force of 2.50 N, (a) what is the magnitude of the acceleration of the cart, and (b) what is the tension in the horizontal string between the pulley and the cart?700) _____

701) A 375-g stone hangs from a thin light string that is wrapped around the circumference of a frictionless pulley with a moment of inertia of 0.0125 kg · m^2 and a radius of 26 cm. When the stone is released, the stone accelerates downward and the pulley rotates about its axis as the string unwinds.
(a) What is the magnitude of the acceleration of the stone?
(b) What is the tension in the string? 701) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

702) As shown in the figure, a 35.30-kg box is attached to a light string that is wrapped around a cylindrical frictionless spool of radius 10.0 cm and moment of inertia 4.00 kg · m^2. The spool is suspended from the ceiling, and the box is then released from rest a distance 3.50 m above the floor. How long does it take for the box to reach the floor?



702) _____

A) 0.892 s B) 5.89 s C) 2.97 s D) 4.18 s E) 2.85 s

703) A 385-g tile hangs from one end of a string that goes over a pulley with a moment of inertia of $0.0125\ \text{kg} \cdot \text{m}^2$ and a radius of 15.0 cm. A mass of 710 g hangs from the other end of the string. When the tiles are released, the larger one accelerates downward while the lighter one accelerates upward. The pulley has no friction in its axle and turns without the string slipping. What is the tension in the string on the side of the 710-g tile? 703) _____

A) 6.87 N B) 5.59 N C) 4.41 N D) 3.68 N E) 9.77 N

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

704) A small 355-g box hangs from one end of a thin light string that goes over a frictionless pulley having a moment of inertia of 0.0125 kg · m^2 and a radius of 15 cm. A second small package, this one of mass 680 g, hangs from the other end of the string. When the packages are released, the larger one accelerates downward, the lighter one accelerates upward, and the pulley turns without the string slipping.
(a) What is the tension in the string on the side of the 355-g package?
(b) At what rate do the packages change their speeds? 704) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
705) The torque required to turn the crank on an ice cream maker is 4.50 N · m. How much work does it take to turn the crank through 300 full turns? 705) _____

A) 4240 J B) 2120 J C) 1350 J D) 8480 J E) 2700 J

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.
706) A ballerina spins initially at 1.5 rev/s when her arms are extended. She then draws in her arms to her body and her moment of inertia becomes 0.88 kg · m^2, and her angular speed increases to 4.0 rev/s. What was her initial moment of inertia? 706) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
707) In a certain cyclotron, a proton of mass 1.67×10^{-27} kg moves in a circle of diameter 1.6 m with an angular speed of 2.0×10^6 rad/s. What is the angular momentum of the proton? 707) _____

A) 1.8×10^{-21} kg · m^2/s B) 3.2×10^{-21} kg · m^2/s
C) 2.1×10^{-21} kg · m^2/s D) 1.3×10^{-21} kg · m^2/s

708) Three solid, uniform, cylindrical flywheels, each of mass 65.0 kg and radius 1.47 m, rotate independently around a common axis through their centers. Two of the flywheels rotate in one direction at 8.94 rad/s, but the other one rotates in the opposite direction at 3.42 rad/s. Calculate the magnitude of the net angular momentum of the system. 708) _____

A) 940 kg · m^2/s B) 1020 kg · m^2/s C) 975 kg · m^2/s D) 1500 kg · m^2/s

709) A uniform, solid, cylindrical flywheel of radius 1.4 m and mass 15 kg rotates at 2.7 rad/s. What is the magnitude of the flywheel's angular momentum? 709) _____

A) 60 kg · m^2/s B) 20 kg · m^2/s C) 80 kg · m^2/s D) 40 kg · m^2/s

710) A uniform 135-g meter stick rotates about an axis perpendicular to the stick passing through its center with an angular speed of 3.50 rad/s. What is the magnitude of the angular momentum of the stick? 710) _____

A) 0.0739 kg · m^2/s
B) 0.0236 kg · m^2/s
C) 0.158 kg · m^2/s
D) 0.0394 kg · m^2/s
E) 0.473 kg · m^2/s

711) An ice skater has a moment of inertia of 5.0 kg · m^2 when her arms are outstretched, and at this time she is spinning at 3.0 rev/s. If she pulls in her arms and decreases her moment of inertia to 2.0 kg · m^2, how fast will she be spinning? 711) _____

A) 3.3 rev/s B) 2.0 rev/s C) 7.5 rev/s D) 10 rev/s

712) A figure skater rotating at 5.00 rad/s with arms extended has a moment of inertia of 2.25 kg · m^2. If he pulls in his arms so his moment of inertia decreases to 1.80 kg · m^2, what will be his new angular speed? 712) _____

A) 4.60 rad/s B) 0.81 rad/s C) 6.25 rad/s D) 2.25 rad/s

713) A solid wood door, 90.0 cm wide by 2.00 m tall has a mass of 35.0 kg. It is open and at rest. A small 500-g ball is thrown perpendicular to the door with a speed of 20.0 m/s and hits the door 60.0 cm from the hinged side. The ball rebounds with a speed of 16.0 m/s along the same line. What is the angular speed of the door just after the collision with the ball? 713) _____

A) 4.57 rad/s
B) 1.14 rad/s
C) 0.127 rad/s
D) 0.925 rad/s
E) 2.28 rad/s

714) A light-weight potter's wheel, having a moment of inertia of $24\,kg \cdot m^2$, is spinning freely at 40.0 rpm. The potter drops a small but dense lump of clay onto the wheel, where it sticks a distance 1.2 m from the rotational axis. If the subsequent angular speed of the wheel and clay is 32 rpm, what is the mass of the clay? 714) _____

A) 4.2 kg B) 4.6 kg C) 3.7 kg D) 2.8 kg

715) A 40.0-kg child running at 3.00 m/s suddenly jumps onto a stationary playground merry-go-round at a distance 1.50 m from the axis of rotation of the merry-go-round. The child is traveling tangential to the edge of the merry-go-round just before jumping on. The moment of inertia about its axis of rotation is 600 kg · m^2 and very little friction at its rotation axis. What is the angular speed of the merry-go-round just after the child has jumped onto it? 715) _____

A) 0.261 rad/s
B) 6.28 rev/s
C) 3.14 rev/s
D) 0.788 rad/s
E) 2.00 rad/s

716) A 5.0-m radius playground merry-go-round with a moment of inertia of 2000 kg · m^2 is rotating freely with an angular speed of 1.0 rad/s. Two people, each of mass 60 kg, are standing right outside the edge of the merry-go-round and suddenly step onto the edge with negligible speed relative to the ground. What is the angular speed of the merry-go-round right after the two people have stepped on? 716) _____

A) 0.60 rad/s B) 0.80 rad/s C) 0.40 rad/s D) 0.67 rad/s E) 0.20 rad/s

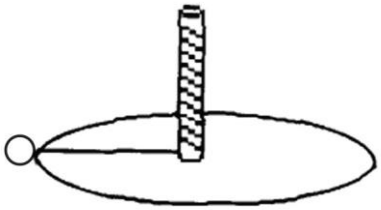
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

717) A 24.5-kg child is standing on the outer edge of a horizontal merry-go-round that has a moment of inertia of $989\,kg \cdot m^2$ about a vertical axis through its center and a radius of 2.40 m. The entire system (including the child) is initially rotating at 0.180 rev/s. Find the angular velocity if the child moves to a new position 1.10 m from the center of the merry-go-round. 717) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

718) Initially, a small 2.0-kg rock is whirling at the end of a very thin string in a circular path of radius 0.75 m on a horizontal frictionless surface, as shown in the figure. The initial tangential speed of the rock was 5.0 m/s. The string has been slowly winding around a vertical rod, and a few seconds later the length of the string has shortened to 0.25 m. What

is the instantaneous speed of the mass at the moment the string reaches a length of 0.25 m?

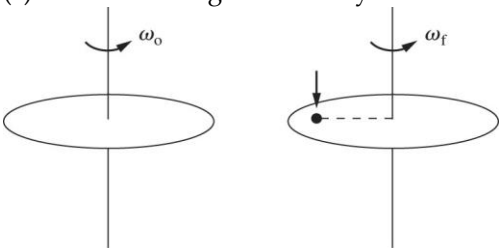


718) _____

A) 225 m/s B) 75 m/s C) 3.9 m/s D) 9.3 m/s E) 15 m/s

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

719) A solid, uniform, horizontal disk with a diameter of 2.0 m and a mass of 4.0 kg freely rotates at 36 rpm about a vertical axis through its center. A small 0.50-kg stone is suddenly dropped onto the disk and sticks to the disk at a distance of 80 cm from the axis of rotation. The figure shows before and after views.
(a) Before the stone fell, what was the moment of inertia of the disk about its central axis?
(b) After the stone stuck, what was the moment of inertia of the system about the same axis?
(c) What is the angular velocity of the disk (in rpm) after the stone fell onto the disk?



719) _____

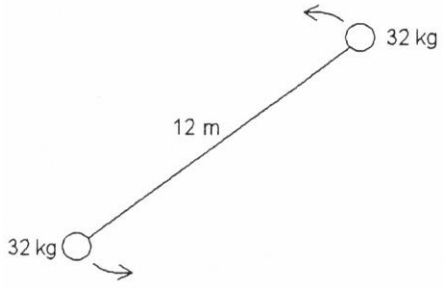
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

720) A puck moves on a horizontal air table. It is attached to a string that passes through a hole in the center of the table. As the puck rotates about the hole, the string is pulled downward very slowly and shortens the radius of rotation, so the puck gradually spirals in towards the center. By what factor will the puck's angular speed have changed when the string's length has decreased to one-half of its original length? 720) _____

A) 1/2 B) $\sqrt{2}$ C) 4 D) 2 E) 1

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

721) NASA puts a satellite into space that consists of two small 32-kg balls connected by a 12-m long light cable, as shown in the figure. The entire system is initially rotating at 4.0 rpm about an axis perpendicular to the cable at the center of mass. Motors in each mass reel out more cable so that the masses double their separation to 24 m.
(a) What is the final rotational speed (in rpm) of the balls?
(b) If the initial rotational kinetic energy of the system was *K*, what is the final rotational kinetic energy in terms of *K*?



721) _____

722) A uniform ball with diameter of 10 cm rolls without slipping on a horizontal tabletop. The moment of inertia of the

ball about an axis through its center is 2.2×10^{-3} kg · m^2, and the translational speed of its center is 0.45 m/s.
(a) What is its angular speed of the ball about its center of mass?
(b) What is the rotational kinetic energy of the ball?
(c) What is the ball's angular momentum about its center of mass? 722) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
723) A solid wooden door, 90 cm wide by 2.0 m tall, has a mass of 35 kg. It is open and at rest. A small 500-g ball is thrown perpendicular to the door with a speed of 20 m/s and hits the door 60 cm from the hinged side, causing it to begin turning. The ball rebounds along the same line with a speed of 16.0 m/s relative to the ground. How much energy is lost during this collision? 723) _____

A) 16 J B) 13 J C) 4.8 J D) 30 J E) 15 J

1) D
2) B
3) B
4) C
5) A
6) C
7) C
8) C
9) B
10) B
11) B
12) B
13) E
14) D
15) D
16) C
17) D
18) D
19) C
20) E
21) D
22) A
23) A
24) A
25) D
26) C
27) D
28) B
29) 1.29 A^2
30) A
31) B
32) C
33) B
34) B
35) B
36) D
37) B
38) A
39) B
40) A
41) A
42) E
43) (a) 10.5 km (b) 2.50 km south
44) D
45) C
46) D
47) B
48) A
49) (a) 0 m/s (b) 4 m/s
50) A
51) D

52) B
53) A
54) C
55) B
56) (a) 67 m/s (b) 0 m/s
57) 117 ms
58) (a) 5.25 km/h (b) 1.25 km/h south
59) E
60) B
61) C
62) C
63) 49 ft
64) 20 seconds
65) 0.00 m/s
66) 1500 m/s^2
67) A
68) 35 days
69) B
70) B
71) C
72) 5.6 s
73) (a) 1.00×10^2 s (b) 62.5 m/s
74) (a) 39 m/s (b) 45 s
75) (a) 1.25×10^6 m/s^2 (b) 0.400 ms
76) C
77) A
78) D
79) A
80) A
81) B
82) C
83) B
84) B
85) B
86) B
87) (a) 4.9 s (b) 60 m
88) (a) 15.0 s (b) 225 m (c) 30.0 m/s
89) D
90) C
91) A
92) B
93) A
94) C
95) A
96) C
97) A
98) *a) 4.4 m/s^2 (b) 120 m
99) E
100) C
101) B
102) A
103) E

104) D
105) A
106) B
107) C
108) 0.67 m/s^2
109) A
110) B
111) B
112) D
113) A
114) C
115) B
116) D
117) C
118) (a) 3.1 s (b) 46 m (c) 11 m/s
119) (a) 3.1 s (b) 46 m (c) 1.0 s and 5.1 s
(d) One value for the ball traveling upward; one value for the ball traveling downward.
120) C
121) C
122) C
123) E
124) E
125) D
126) A
127) D
128) 5.53 m/s
129) 190 m
130) 2.4 s
131) C
132) C
133) E
134) D
135) C
136) A
137) D
138) C
139) D
140) C
141) 1.5 m/s^2
142) (a) 1.0 m/s (b) 0 m/s
143) (a) 0.67 m/s (b) 1.3 m/s
144) 3.0 m/s
145) C
146) C
147) A
148) (a) $-x$ (b) $+x$ (c) 1.5 m/s^2 (d) 1.0 s
149) (a) 10 m/s (b) 20 m/s (c) 0 m/s (d) -40 m/s
150) (a) 10 m/s (b) 0 m/s
151) (a) 10 m/s^2 (b) 0 m/s^2
152) (a) 2.0 m/s^2 (b) -2.5 m/s^2
153) 42 m/s at 31° north of west
154) E

155) B
156) D
157) B
158) +6.6 units and -6.6 units
159) D
160) A
161) (a) 22.6° (b) 13.0 m
162) (a) 5.00 m (b) 53.1°
163) C
164) A
165) D
166) D
167) C
168) B
169) A
170) C
171) D
172) D
173) 6.6 lb at 68° clockwise from rope A
174) (a) 6.6 (b) 170°
175) (a) A_x = 5.5 cm, A_y = 0 cm (b) B_x = -6.5 cm, B_y = 3.8 cm
(c) R_x = -1.0 cm, R_y = 3.8 cm (d) 3.9 cm at 75° above the -*x* axis
176) (a) A_x = 65 cm, A_y = 38 cm (b) B_x = -25 cm, B_y = 0 cm
(c) C_x = -28 cm, C_y = -28 cm (d) R_x = 12 cm, R_y = 9 cm
(e) 15 cm at 38° above the +*x*-axis
177) C
178) E
179) E
180) D
181) A
182) B
183) B
184) D
185) C
186) C
187) 1.6 lb, 312°
188) 35 m at 39° north of east
189) C
190) (a) 185 N (b) 77.8° above the +*x*-axis
191) A
192) A
193) B
194) C
195) -11 cm (*x* component), -4.5 cm (*y* component)
196) 14.4 m
197) D
198) 0.00 cm (*x* component), 4.2 cm (*y* component)
199) 4.2 cm along the +*y*-axis
200) 85 m at 5.4° above the +*x*-axis
201) 100 m at 31° above the +*x*-axis
202) B
203) C

204) (a) 20 m (b) 0 m
205) 18 m/s
206) C
207) D
208) B
209) D
210) D
211) 68 m
212) D
213) D
214) A
215) D
216) A
217) C
218) 963 m
219) 140 m
220) 33 m/s
221) (a) 75.0 cm (b) 0.505 s
222) (a) 0.821 s (b) 267 m
223) (a) 25 m (b) 27 m
224) (a) 19 m/s (b) 31 m/s
225) (a) 12 m/s (b) 25 m/s
226) 35 m/s
227) C
228) D
229) A
230) B
231) A
232) D
233) (a) 3.4 s (b) 78 m (c) v_{horiz} = 23.4 m/s, v_{vert} = 33 m/s downward
234) B
235) B
236) D
237) D
238) A
239) 45°
240) C
241) E
242) B
243) E
244) E
245) (a) 7.5 m (b) 1.2 s (c) 9.1 m/s
246) D
247) D
248) B
249) D
250) (a) 3.7 s (b) 68 m (c) $v_{\text{horizontal}}$ = 42 m/s, v_{vertical} = 0 m/s
(d) $a_{\text{horizontal}}$ = 0 m/s^2, a_{vertical} = -9.8 m/s^2
251) 27.4 m/s
252) 96 m
253) 10 m/s
254) (a) 67 m/s (b) 340 m (c) 190 m

255) A
256) D
257) D
258) A
259) B
260) A
261) D
262) C
263) 120 km/h
264) B
265) D
266) C
267) 61°
268) B
269) 20 m/s at 15° east of south
270) 11 m/s at 63° north of east
271) 94 m/s at 32° north of east
272) (a) 60° (b) 3.1 min
273) (a) Alice (b) Alice arrives 110 s before John
274) A
275) E
276) D
277) B
278) B
279) B
280) (a) 0.775 m/s (b) 1.57 m/s
281) D
282) C
283) C
284) (a) 60,000 N (b) 35,000 N
285) B
286) 160 N
287) D
288) C
289) 220 N
290) B
291) D
292) B
293) A
294) C
295) B
296) E
297) mass = 60 kg, weight = 98 N
298) A
299) E
300) C
301) C
302) (a) 310 N (b) 470 N
303) D
304) B
305) D
306) D

307) E
308) 600 N
309) D
310) C
311) 1.5×10^{-13} N
312) 400 N
313) 3.0 m/s^2
314) 160 N
315) 1.1×10^4 N
316) (a) 1300 N (b) upward
317) B
318) 2.3m/s^2, downward
319) D
320) C
321) A
322) B
323) B
324) B
325) A
326) A
327) C
328) 147 N
329) E
330) (a) 38 N (b) 260°
331) C
332) A
333) C
334) (a) 5 (b) the top wire
335) C
336) B
337) (a) 22 kg (b) 270 N
338) C
339) C
340) A
341) A
342) B
343) (a) 4.6 m/s^2 (b) upper string
344) 210,000 N
345) (a) 94 N (b) 45 N
346) 72 N (link A), 63 N (link B)
347) A
348) B
349) A
350) (a) 190 N (b) 4.9 kg
351) A
352) (a) 60,000 N (b) 35,000 N
353) C
354) 160 N
355) E
356) B
357) 220 N
358) C

359) A
360) A
361) C
362) A
363) D
364) A
365) C
366) D
367) B
368) B
369) B
370) B
371) (a) 84 N (b) 48 N
372) (a) 3.6 kg (b) 0.98 m/s^2
373) 0.44 m/s^2, to the left
374) E
375) (a) 6.6 m/s^2 down the ramp (b) 6.6 m/s^2 down the ramp
376) (a) 1.3 s (b) 7.1 m/s
377) C
378) (a) 2.1 m/s^2 (b) 42 N
379) 45 N
380) 5.6 m
381) (a) 11 m/s^2 down the ramp (b) 1.2 m/s^2 down the ramp
382) D
383) B
384) D
385) 2.1 m/s
386) 2.5 kg
387) B
388) C
389) B
390) A
391) A
392) D
393) 3.5 cm
394) (a) 46 cm (b) 32 cm (c) 32 cm
395) 19 cm
396) A
397) C
398) B
399) B
400) B
401) D
402) (a) 275 Kj (b) -245 kJ (c) 30.0 kJ
403) D
404) B
405) B
406) -59 J
407) C
408) C
409) A
410) B

411) D
412) C
413) D
414) E
415) C
416) 7.1 m/s
417) D
418) C
419) B
420) C
421) B
422) C
423) D
424) D
425) D
426) B
427) D
428) C
429) C
430) A
431) B
432) B
433) D
434) A
435) D
436) D
437) (a) +8.2 m/s (b) +2.0 m/s
438) 14 m
439) C
440) C
441) A
442) A
443) D
444) 3.2×10^6 m/m
445) C
446) A
447) C
448) A
449) A
450) A
451) C
452) D
453) C
454) C
455) B
456) D
457) (a) 27 cm (b) 2.3 m/s
458) D
459) B
460) B
461) E
462) E

463) B
464) A
465) A
466) D
467) C
468) A
469) 48 m
470) A
471) B
472) B
473) A
474) B
475) 160 J
476) D
477) C
478) D
479) E
480) C
481) 3.7 m
482) 1.9 m/s
483) 4.3 m/s
484) 5.4 MJ
485) A
486) A
487) C
488) B
489) B
490) C
491) 920 km
492) A
493) 3.1 MW
494) B
495) $4.03
496) (a) $17 (b) 6.05×10^8 J
497) (a) 0.25 Kj (b) 0.12 kW (c) the same work, but the power doubles
498) (a) 6.3 kJ (b) 290 W (c) 0.39 hp
499) C
500) 10 s
501) C
502) 6.30 kg · m/s
503) C
504) E
505) C
506) B
507) B
508) E
509) A
510) 123 kg . m/s , 212°
511) E
512) E
513) 0.60 m/s
514) 0.875 m/s

515) 0.280 m/s
516) A
517) B
518) 8.7 m/s
519) A
520) A
521) B
522) D
523) C
524) B
525) E
526) A
527) A
528) C
529) E
530) 8.8 N · s
531) 4900 N
532) (a) 0.20 kN (b) 100
533) 17 N · s
534) E
535) E
536) A
537) C
538) B
539) 7.64 ms
540) B
541) D
542) B
543) B
544) C
545) E
546) A
547) C
548) C
549) 5.6×10^{25} per second
550) A
551) 7.57 m/s
552) D
553) C
554) A
555) A
556) E
557) C
558) A
559) D
560) A
561) D
562) B
563) B
564) (a) 1.2 m/s toward the east (b) 4.9 m/s toward the east (c) Yes, it is an elastic collision.
565) 6.3 m/s
566) 14.3 m/s

567) E
568) A
569) A
570) C
571) B
572) C
573) B
574) A
575) B
576) B
577) (a) 18 N · s (b) 31%
578) E
579) D
580) E
581) E
582) A
583) (a) 1.3 m/s (b) 0.089 m (c) No, this is an inelastic collision.
584) A
585) A
586) D
587) C
588) (a) 3.50 cm, (b) 6.13 J during the inelastic collision
589) 21 m/s
590) C
591) A
592) C
593) C
594) A
595) C
596) 7.00 m to the right of the 2.00 kg ball, 1.11 m/s to the right
597) A
598) D
599) (2.8 m, -2.8 m)
600) C
601) B
602) B
603) 1.3 cm, -1.0 cm
604) 0.78×10^6 km from the center of the sun, just outside the solar surface
605) 3.84×10^8 m
606) 1.4×10^9 m
607) C
608) D
609) 3.49 rad/s
610) 0.0011 rad/s
611) E
612) A
613) A
614) 40 cm
615) (a) 0.627 rad/s (b) 1.18 m/s^2
616) 140°
617) (a) 1.0 m/s (b) 2.9 rad/s
618) C

619) A
620) D
621) E
622) D
623) (a) 110 rad (b) 48 rad/s (c) 210 m/s^2 (d) 0 m/s^2
624) B
625) A
626) (a) 0.63 rad/s^2 (b) 1.5 rev
627) (a) 11 rad (b) 10 rad/s
628) 0.73 s
629) 0.67 s
630) C
631) C
632) B
633) A
634) E
635) (a) 0.020 m/s^2 (b) 0.35 m/s (c) 0.066 m/s^2 (d) 35 s
636) D
637) C
638) D
639) C
640) 1.4 s
641) B
642) (a) 230 rad/s^2 (b) 1.7 s
643) 0.36 $kg \cdot m^2$
644) B
645) E
646) (a) 6.48 $kg \cdot m^2$ (b) 32.7 $kg \cdot m^2$
647) (a) 19.4 $kg \cdot m^2$ (b) 76.2 $kg \cdot m^2$
648) 24.9 $kg \cdot m^2$
649) B
650) D
651) A
652) D
653) (a) 34.2 J (b) 173 J
654) 403 J
655) 221 m/s
656) 1.8 rad/s
657) B
658) A
659) C
660) D
661) E
662) D
663) B
664) D
665) C
666) 2.4 m/s
667) E
668) C
669) A

670) B
671) E
672) A
673) A
674) (a) 5.42 m/s (b) 24.5 J
675) (a) 3.7 m/s (b) 4.4 m/s
(c) With friction, some of the initial potential energy goes into rotational kinetic energy, leaving less for translational kinetic energy. Without friction, the ball does not rotate, so all the initial potential energy goes into translational kinetic energy.
676) (a) 7.1 m (b) 5.1 m
(c) With friction, all the initial kinetic energy (translational and rotational) goes into potential energy. Without friction, only the translational kinetic energy goes into potential energy; the ball keeps spinning at the same rate as it goes up, even at the top.
677) (a) 8.4 m/s, 56 rad/s (b) 11 m/s, 0 rad/s
678) E
679) D
680) D
681) E
682) A
683) A
684) B
685) 8.50 rad/s^2
686) B
687) D
688) C
689) D
690) B
691) E
692) A
693) 1.6 m/s^2
694) C
695) B
696) B
697) A
698) B
699) (a) 4.5 rad/s^2 (b) 3.0 m/s^2
700) (a) 6.53 m/s^2 (b) 2.29 N
701) (a) 6.6 m/s^2 (b) 1.2 N
702) C
703) B
704) (a) 4.2 N (b) 2.0 m/s^2
705) D
706) 2.3 $kg \cdot m^2$
707) C
708) B
709) D
710) D
711) C
712) C
713) B
714) A

715) A
716) C
717) 0.200 rev/s
718) E
719) (a) 2.0 kg · m^2 (b) 2.3 kg · m^2 (c) 31 rpm
720) C
721) (a) 1.0 rpm (b) $K/4$
722) (a) 9.0 rad/s (b) 0.089 J (c) 0.020 kg · m^2/s
723) D