Q1.
Two objects are thrown from the top of a building with the same speed, the first upward and the second downward. When they reach the ground (neglect air resistance):

A) The two objects have the same velocity.
B) The first object has the higher velocity.
C) The second object has the higher velocity.
D) The answer depends on the masses of the objects.
E) The answer depends on the shapes of the objects.

Q2.
A car travels 180 km at a constant speed of 90.0 km/h to point A. It then travels another 180 km with a constant speed of 60.0 km/h to point B. Its average speed (in km/h) for the entire trip is:

A) 72.0
B) 75.7
C) 15.9
D) 30.0
E) 36.4

Q3.
A cannon is capable of firing a steel ball a maximum height of 5.00×10^2 m vertically upward (above its firing level). What would be the maximum range for this cannon?

A) 10.0×10^2 m
B) 5.00×10^2 m
C) 7.50×10^2 m
D) 1.50×10^2 m
E) 3.50×10^2 m

Q4.
A vector $\vec{B}$ is given by $\vec{B} = 2.0\,\hat{i} + 2.0\,\hat{j} + 2.0\,\hat{k}$. Which one of the following represents a unit vector in the direction of $\vec{B}$?

A) $0.58\,\hat{i} + 0.58\,\hat{j} + 0.58\,\hat{k}$
B) $2.0\,\hat{i} + 2.0\,\hat{j} + 2.0\,\hat{k}$
C) $0.45\,\hat{i} + 0.56\,\hat{j} + 0.67\,\hat{k}$
D) $0.29\,\hat{i} + 0.32\,\hat{j} + 0.78\,\hat{k}$
E) $1.0\,\hat{i} + 1.0\,\hat{j} + 1.0\,\hat{k}$

Q5.

Two bodies of different masses *M* and *m* are raised to the same height above the floor, and released from rest simultaneously. Assuming that air resistance is constant and identical on the two bodies, which one of the following statements is true?

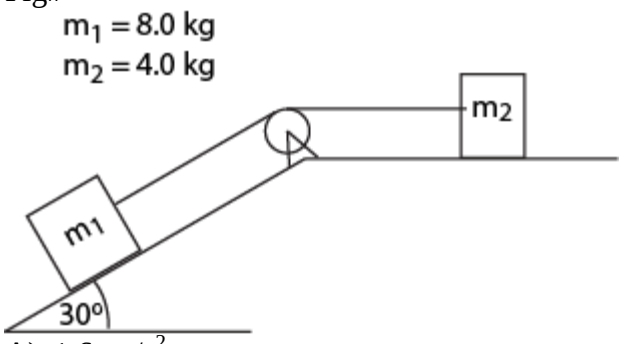
A) The larger mass reaches the floor first.
B) The two masses reach the floor at the same time.
C) The smaller mass reaches the floor first.
D) There is not enough information to say which one of the two masses will reach the floor first.
E) The two masses have the same speed as they reach the floor.

Q6.
Object A of mass *M* and object B of mass 4*M* are initially at rest. Both objects are then pushed by equal forces for equal distances on a horizontal frictionless surface. At the end of the push, compared to the kinetic energy of object A, the kinetic energy of object B is

A) the same.
B) twice as much.
C) half as much.
D) four times as much.
E) one-fourth as much.

Q7.
Figure 1 shows two blocks with masses m_1= 8.0 kg and m_2 = 4.0 kg, connected by a light string. The coefficient of kinetic friction between m_2 and the horizontal surface is 0.50 while the inclined plane is frictionless. Find the acceleration of the system (neglect the mass of the pulley).

Fig#

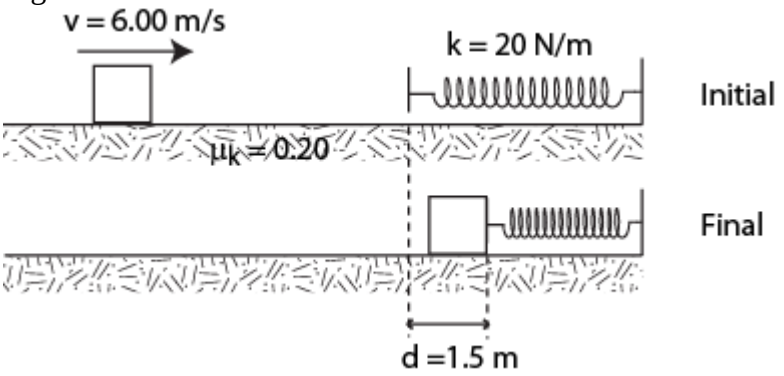


A) 1.6 m/s^2
B) 2.5 m/s^2
C) 0.65 m/s^2
D) 1.2 m/s^2
E) 3.7 m/s^2

Q8.

Figure 2 shows a 3.00 kg block moving on a rough horizontal surface. The block strikes a spring with a spring constant k = 20.0 N/m and compresses it 1.50 m before coming to rest. The coefficient of kinetic friction between the block and the surface is 0.200. Calculate the speed of the block just before it strikes the spring.

Fig#



A) 4.57 m/s
B) 6.45 m/s
C) 3.25 m/s
D) 9.21 m/s
E) 6.00 m/s

Q9.
An ideal spring is hung vertically from a ceiling. When a 2.0 kg mass hangs at rest from it, the spring is extended 5.0 cm from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 8.0 cm. While the spring is being extended by the external force, the work done by the spring is:

A) −2.8 J
B) −3.3 J
C) −1.0 J
D) +1.8 J
E) +3.6 J

Q10.
An object of mass 1.0 kg is thrown vertically upward from the ground and returns to the ground after 10 s. Neglecting air resistance, what is the change in the linear momentum of the object?

A) 98 N.s downward
B) 98 N.s upward
C) 50 N.s downward
D) 50 N.s upward
E) 0 N.s

Q11.

What is the moment of inertia of a rigid body in rotational motion about a fixed axis with angular momentum L = 10.0 kg.m^2.s^{-1} and a rotational kinetic energy K = 0.500 J?

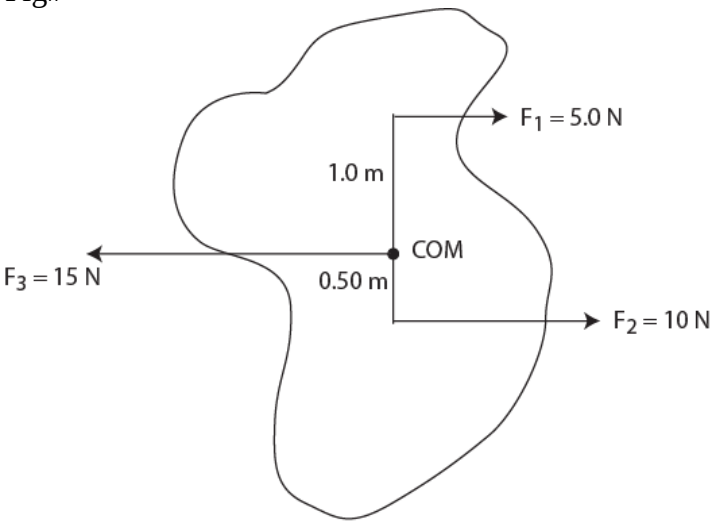
A) 100 kg.m^2
B) 10.0 kg m^2
C) 20.0 kg.m^2
D) 200 kg.m^2
E) None of the others

Q12.
A certain wire stretches 0.90 cm when two outward forces of equal magnitude are applied to it, one at each end. The same forces are then applied to a second wire made of the same material but with three times the diameter and three times the length. The second wire stretches:

A) 0.30 cm
B) 0.10 cm
C) 0.90 cm
D) 2.7 cm
E) 8.1 cm

Q13.
Three forces, F_1 = 5.0 N, F_2 = 10 N, and F_3 = 15 N are acting on a body as shown in **Figure 3**. Choose the correct answer (COM stands for center of mass):

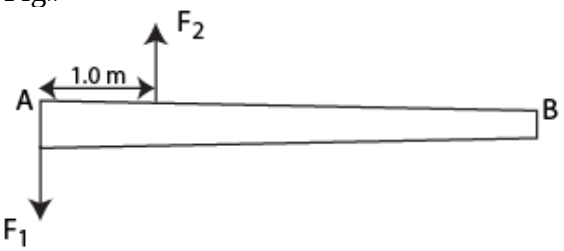
Fig#



A) The body is in both translational and rotational equilibrium.
B) The body is only in rotational equilibrium.
C) The body is only in translational equilibrium.
D) The body is neither in rotational equilibrium nor in translational equilibrium.
E) The body is moving horizontally with a uniform acceleration.

Q14.
A man holds horizontally a non-uniform rod AB of length = 6.0 m and weight = 30 N in equilibrium, by exerting a downward force $\mathbf{F_1}$, with one hand, at the end A and an upward force $\mathbf{F_2}$, with the other hand, at a point 1.0 m from A as shown in **Figure 4**. If the magnitude of $\mathbf{F_1}$ is half that of $\mathbf{F_2}$, find the location of the center of mass of the rod from the point A.

Fig#



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

Q15.
Find the acceleration due to gravity on a planet whose mass is four times the mass of Earth and whose radius is half the radius of Earth (g is the acceleration due to gravity on Earth).

A) 16 *g*
B) *g*
C) 4 *g*
D) 2 *g*
E) 8 *g*

Q16.
Find the speed in m/s that an object must have on the surface of Earth in order to escape from the gravitational field (pull) of Earth with a speed of 2.00×10^4 m/s.

A) 2.29×10^4
B) 11.2×10^4
C) 11.2×10^6
D) 6.30×10^6
E) 7.45×10^5

Q17.

Three masses m_1 = 2.0 kg, m_2 = 5.0 kg, and m_3 = 20 kg are placed at the corners of an equilateral triangle of sides 0.50 m. Find the gravitational potential energy of the system of these three particles.

A) -2.0×10^{-8} J
B) $+2.0 \times 10^{-8}$ J
C) -5.0×10^{-8} J
D) $+5.0 \times 10^{-8}$ J
E) -9.0×10^{-8} J

Q18.
A satellite of mass 125 kg is in a circular orbit of radius 7.00×10^6 m around a certain planet. If the period of revolution of the satellite is 8.05×10^3 s, what is its mechanical energy?

A) -1.87×10^9 J
B) $+1.87 \times 10^9$ J
C) -2.37×10^9 J
D) $+5.67 \times 10^8$ J
E) -5.34×10^9 J

Q19.
The potential energy of a satellite-planet system is -3.2×10^6 J. What is the kinetic energy of the satellite in its orbit?

A) $+1.6 \times 10^6$ J
B) -1.6×10^6 J
C) -3.2×10^6 J
D) $+3.2 \times 10^6$ J
E) $+9.8 \times 10^6$ J

Q20.
An iceberg floats on the sea. Its volume above the seawater is 8.0×10^2 m^3. Assume the density of ice to be 9.0×10^2 kg/m^3 and the density of seawater to be 1.2×10^3 kg/m^3. The total mass of the iceberg is:

A) 2.9×10^6 kg
B) 7.2×10^5 kg
C) 1.8×10^6 kg
D) 9.6×10^5 kg
E) 1.1×10^6 kg

Q21.

An aluminum ball of volume 4.0 cm^3 is dropped in water. Assume the density of water to be 1.0 g/cm^3 and the density of aluminum to be 2.7 g/cm^3. Find the acceleration with which the ball sinks in the water (ignore viscosity).

A) 6.2 m/s^2
B) 7.5 m/s^2
C) 9.8 m/s^2
D) 4.9 m/s^2
E) 0 m/s^2

Q22.
The pressure on a submarine is 1.00×10^6 Pa. Assume that the density of seawater is 1.20×10^3 kg/m^3. The depth of the submarine below the surface of seawater is:

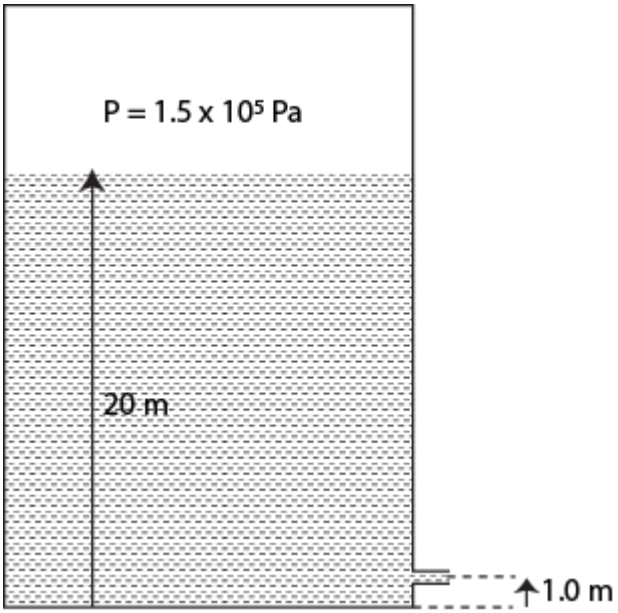
A) 76.4 m
B) 91.7 m
C) 7.64 m
D) 100 m
E) 9.17 m

Q23.
A pipe 16 cm in diameter is connected to the top of a water storage tank of volume 1.0×10^4 liters. If the tank is filled at a constant rate in 10 minutes, what is the entry speed of water from the pipe into the tank? 1 liter = 10^{-3} m^3

A) 50 m/min.
B) 40 m/min.
C) 20 m/min.
D) 25 m/min.
E) 10 m/min.

Q24.
Figure 5 shows a very large, closed, cylindrical oil tank. There is a small hole in its side at a height of 1.0 m from the bottom of the tank. The oil vapor pressure in the tank is maintained at 1.5×10^5 Pa. Find the speed with which the oil leaves the tank through the hole when the oil level is 20 m from the bottom of the tank. The density of oil is 8.5×10^2 kg/m^3.

Fig#



A) 22 m/s
B) 11 m/s
C) 44 m/s
D) 33 m/s
E) 55 m/s

Q25.
Which one of the following relationships between the acceleration *a* and the displacement *X* of a particle represents simple harmonic motion:

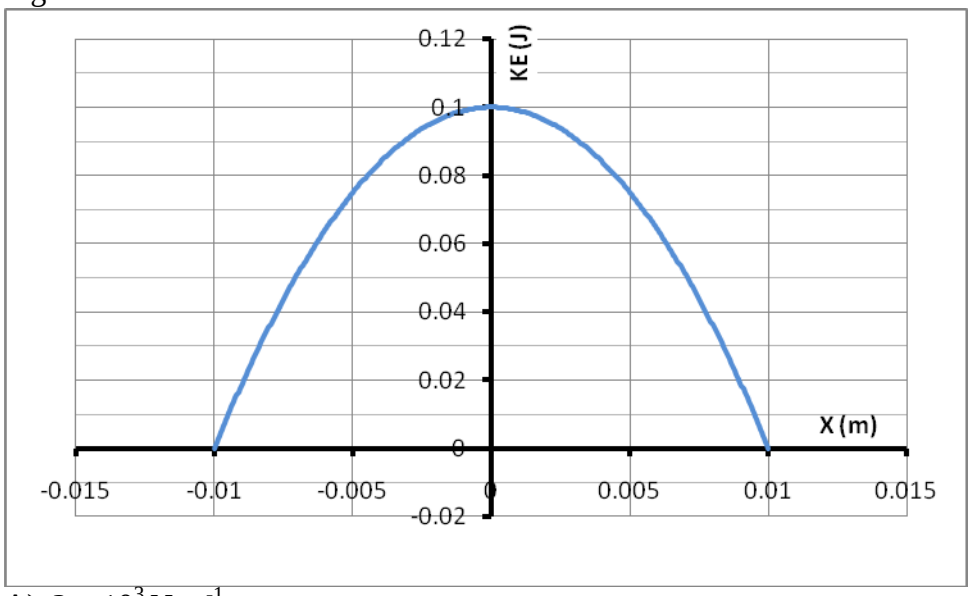
A) $a = -2X$
B) $a = +2X$
C) $a = -2X^2$
D) $a = +2X^2$
E) None of the others

Q26.
A simple pendulum has a length of 1.00 m and a mass of 0.250 kg. How many oscillations will it complete in 5.00 minutes in a location where g = 10.5 m/s^2?

A) 155
B) 100
C) 477
D) 501
E) 582

Q27.
Figure 6 shows the kinetic energy *KE(J)* versus the displacement *X(m)* of a spring-mass system from its equilibrium position while undergoing a simple harmonic motion. What is the spring constant *k*?

Fig#



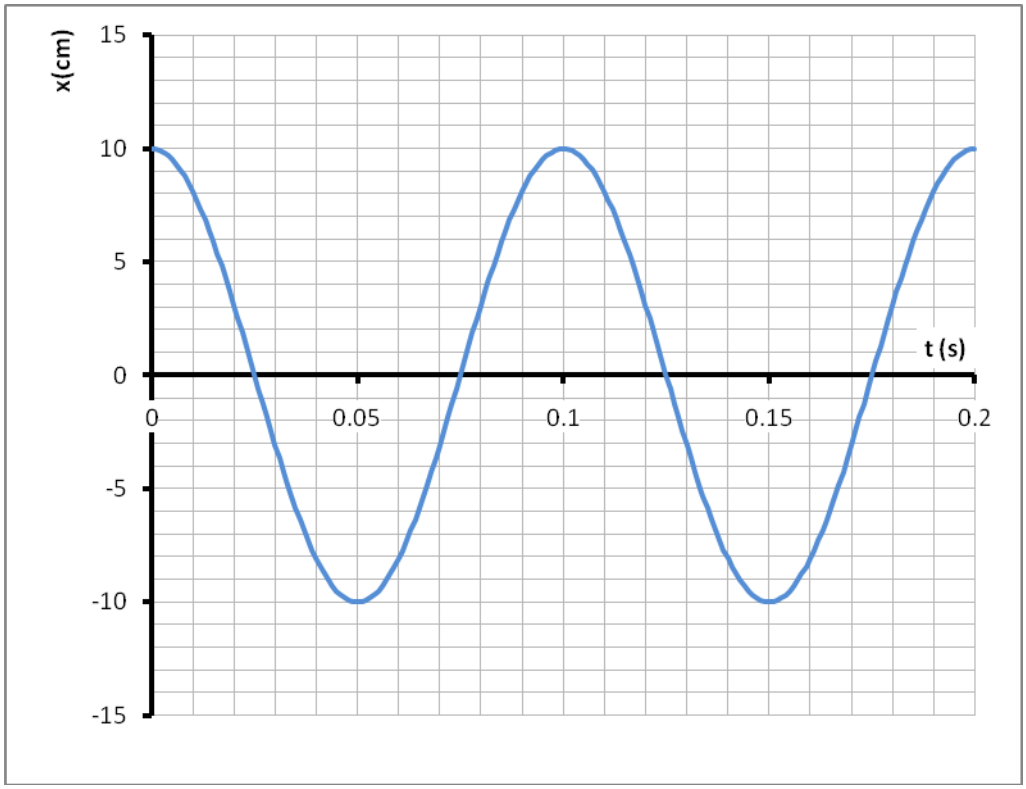
A) 2×10^{3} N.m^{-1}
B) 2×10^{1} N.m^{-1}
C) 2×10^{-1} N.m^{-1}
D) 2×10^{-2} N.m^{-1}
E) None of the others

Q28.
A mass-spring system is in simple harmonic motion in a horizontal plane. The position of the mass is given by $x = x_m cos(\omega t + \frac{\pi}{3})$. What is the ratio of its potential energy to its total energy at t = 0 s.

A) 0.25
B) 0.50
C) 0.75
D) 1.00
E) 0.00

Q29.
Figure 7 shows the position x(cm) as a function of time t(s) of a 100-gram block oscillating in simple harmonic motion on the end of a spring. What is the maximum kinetic energy of the block?

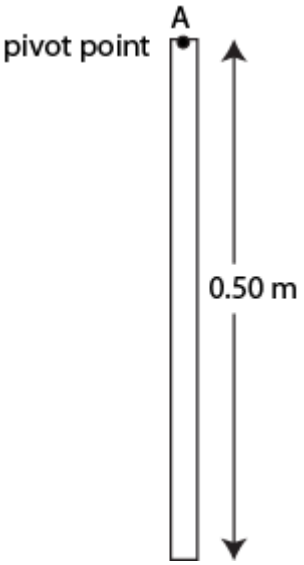
Fig#



A) 1.97 J
B) 0.314 J
C) 19.7 J
D) 3.95 J
E) 39.5 J

Q30.
Figure 8 shows a physical pendulum which consists of a 0.500-meter long thin uniform rigid rod hung from a pivot through point A. What is the pendulum's period of oscillations about point A?

Fig#



A) 1.16 s
B) 1.42 s
C) 1.64 s
D) 2.83 s
E) 2.01 s