Q1.
A 2.0 *kg* mass moves with an acceleration $\vec{a} = \left(2.0\,\hat{i} - 1.0\,\hat{j}\right) m/s^2$ under the action of three forces, $\vec{F}_1 = \left(1.0\,\hat{i} + 2.0\,\hat{j}\right) N$, $\vec{F}_2 = \left(3.0\,\hat{i} + 1.0\,\hat{j}\right) N$, and $\vec{F}_3$. Find the force $\vec{F}_3$.

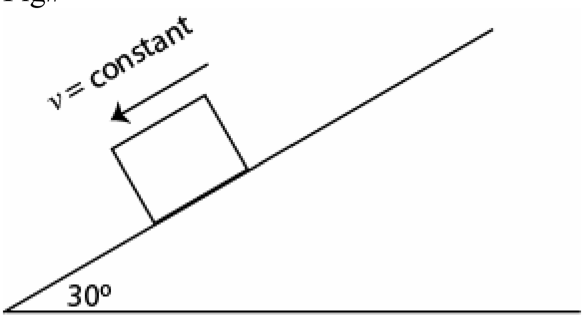
A) $\left(-5.0\,\hat{j}\right) N$
B) $\left(2.0\,\hat{i} - 1.0\,\hat{j}\right) N$
C) $\left(4.0\,\hat{i} + 3.0\,\hat{j}\right) N$
D) $\left(-2.0\,\hat{i} + 1.0\,\hat{j}\right) N$
E) $\left(2.0\,\hat{i}\right) N$

Q2.
A 100 *kg* man standing on a scale in a moving elevator reads his weight as 490 *N*. The acceleration of the elevator is:

A) 4.9 m/s^2 downward
B) 4.9 m/s^2 upward
C) 9.8 m/s^2 upward
D) 9.8 m/s^2 downward
E) zero

Q3.
A 10 *kg* block is moving down a 30° incline rough surface with a constant velocity (see Fig. 1). The coefficient of kinetic friction μ_k between the block and inclined surface is:

Fig#



A) 0.58
B) 0.25
C) 0.20
D) 0.10
E) 0.76

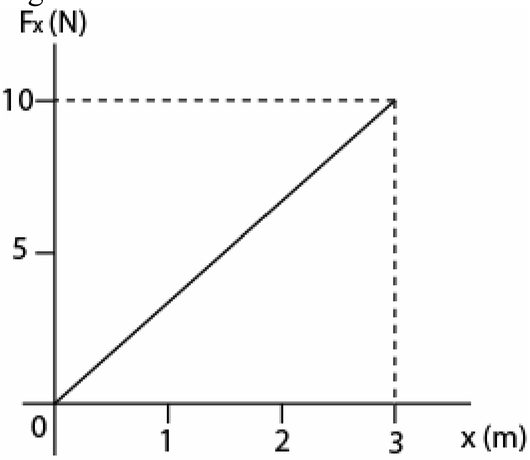
Q4.

Consider the following two vectors: $\vec{A} = \hat{i} - \hat{j}$, and $\vec{B}$ described as having a magnitude = 2.0 and directed 45° above the positive x axis. The angle between $\vec{A}$ and $\vec{B}$ is:

A) 90°
B) 45°
C) zero
D) 63°
E) 147°

Q5.
Fig 2 gives the only force acting on a block (F_x) versus the block's position (x). If the block had an initial kinetic energy of 5.0 *J* at x = 0, then the kinetic energy at x = 3.0 *m* is:

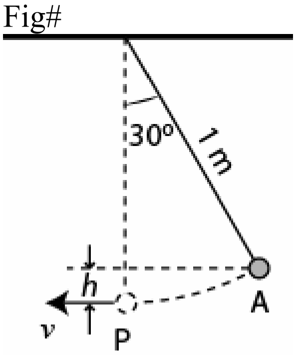
Fig#



A) 20 *J*
B) 10 *J*
C) 35 *J*
D) zero
E) 30 *J*

Q6.
A simple pendulum consists of a 2.0 *kg* mass attached to a 1.0 *m* long string. It is released from rest at an angle of 30º (point A) as shown in Fig 3. Its speed (*v*) at the lowest point *P* is:

Fig#

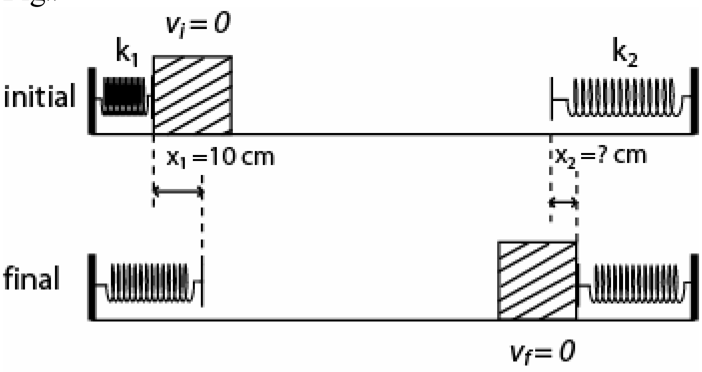


A) 1.6 m/s

B) 0.9 m/s
C) 6.0 m/s
D) 3.6 m/s
E) 36 m/s

Q7.
Two springs of spring constants $k_1 = 40$ *N*/*m* and $k_2 = 160$ *N*/*m* are fixed opposite to each other on a frictionless floor as shown in Fig. 4. A 0.50 *kg* block, not attached to any of the springs, oscillates between the two springs. If the block compresses the first spring by a maximum distance of 10 *cm* then it will compress the second spring by a maximum distance of:

Fig#



A) 5.0 *cm*
B) 2.5 *cm*
C) 10 *cm*
D) 7.1 *cm*
E) 0.20 *cm*

Q8.
A car moves on a horizontal circular road of radius 20 *m* at a constant speed *v*. The magnitude of its acceleration is 5.0 m/s^2. Find the value of *v*.

A) 10 *m*/*s*
B) 20 *m*/*s*
C) zero
D) 40 *m*/*s*
E) 400 *m*/*s*

Q9.
A stone is thrown outward from the top of a 59.4 *m* high cliff with a velocity $\left(15\,\hat{i} + 20\,\hat{j}\right) m/s$. The speed of the stone at the highest point is:

A) 15 *m*/*s*
B) 20 *m*/*s*
C) 25 *m*/*s*

D) zero
E) 8.0 m/s

Q10.
Block *A*, with a mass of 4.0 *kg*, is moving with a velocity of $\left(3.0\,\hat{i}\right) m/s$ while block *B*, with a mass of 8.0 *kg*, is moving with a velocity of $\left(3.0\,\hat{j}\right) m/s$. The center of mass of the two block-system is moving with a velocity of:

A) $\left(\hat{i} + 2.0\,\hat{j}\right) m/s$
B) $\left(3.0\,\hat{i} + 2.0\,\hat{j}\right) m/s$
C) $\left(3.0\,\hat{i} + 3.0\,\hat{j}\right) m/s$
D) $\left(2.0\,\hat{i} + 2.0\,\hat{j}\right) m/s$
E) $6.0\, m/s$

Q11.
A rifle of mass *M* is initially at rest but free to recoil. It fires a bullet of mass *m* and velocity *v* (relative to the ground). After firing, the velocity of the rifle (relative to the ground) is:

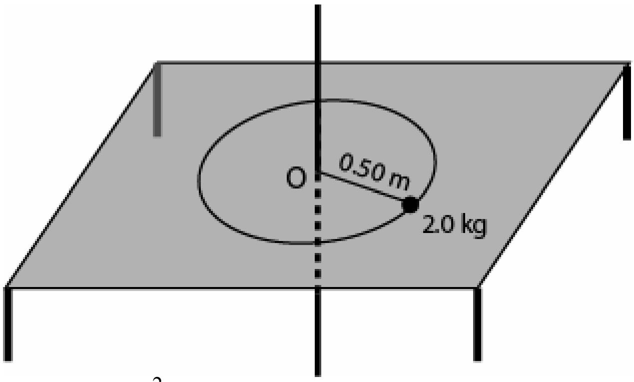
A) $-\,m\,v\,/\,M$
B) $-\,M\,v\,/\,m$
C) $-\,mv$
D) $-\,v$
E) $m\,v\,/\,M$

Q12.
A disk rolls smoothly down a 30° inclined plane. The magnitude of the linear acceleration of the center of mass is:

A) 3.3 m/s^2
B) 9.8 m/s^2
C) 4.9 m/s^2
D) 0.98 m/s^2
E) 2.0 m/s^2

Q13.
A 2.0 *kg* particle moves in a circular path of radius 0.50 m on a horizontal table with a constant speed v = 10 m/s (see Fig. 5). The magnitude of its angular momentum about the center of the circle (O) is:

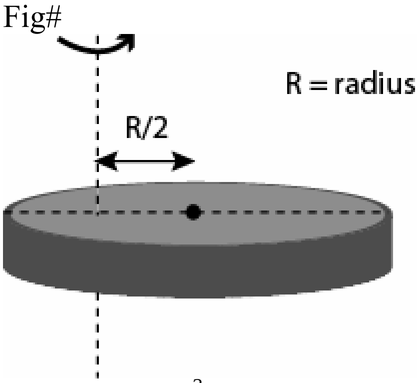
Fig#



A) 10 $kg.m^2/s$
B) 5.0 $kg.m^2/s$
C) 2.5 $kg.m^2/s$
D) 20 $kg.m^2/s$
E) zero

Q14.
The rotational inertia of a disk of mass = *M* and radius = *R* about a perpendicular axis a distance = *R*/2 from the center of the disk is (see Fig. 6):

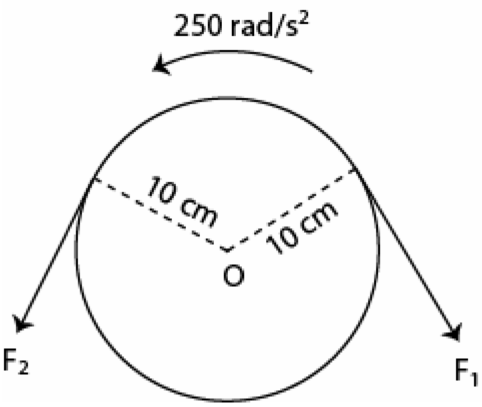
Fig#



A) (3 / 4) $M R^2$
B) (1 / 2) $M R^2$
C) (1 / 4) $M R^2$
D) (2 / 5) $M R^2$
E) (2 / 3) $M R^2$

Q15.
Fig. 7 shows a uniform disk of radius 10.0 cm and rotational inertia of 0.010 $kg{\cdot}m^2$ about an axis through its center O. Its angular acceleration is 250 rad/s^2 counterclockwise. Given that F_1= 50 .0 *N*, the force F_2 is:

Fig#



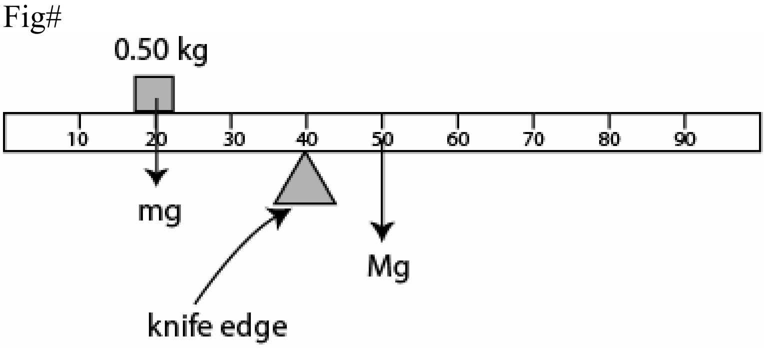
A) 75 *N*
B) 50 *N*
C) 100 *N*
D) 9.8 *N*
E) 25 *N*

Q16.
The volume of a solid Aluminum sphere at the sea level is V = 1.0 m^3. This sphere is placed at a depth of about 700 *m* in the sea where the absolute pressure is p = 7.0 x 10^6 N/m^2. The change in the volume $(|\Delta V|)$ of the sphere is: (the bulk modulus of Aluminum, B = 70 x10^9 N/m^2).

A) 1.0 x 10^{-4} m^3
B) 2.0 x 10^{-4} m^3
C) 3.0 x 10^{-4} m^3
D) 4.0 x 10^{-4} m^3
E) 5.0 x 10^{-4} m^3

Q17.
A uniform meter stick of mass *M* is balanced on a knife edge at the 40 *cm* mark by hanging a 0.50 *kg* mass at the 20 *cm* mark (see Fig. 8). Find *M*.

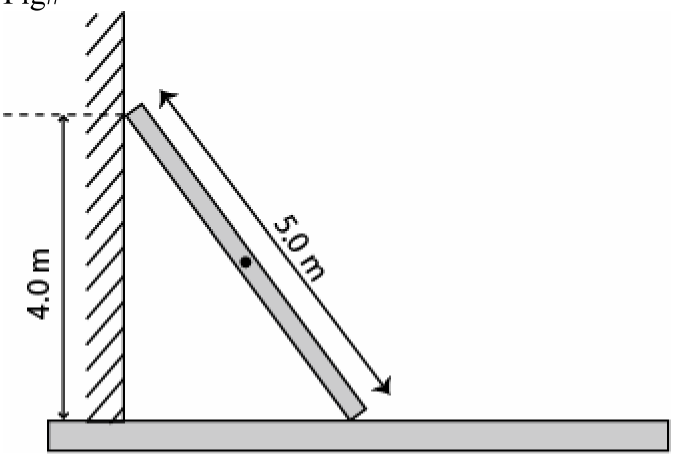
Fig#



A) 1.0 *kg*
B) 2.0 *kg*
C) 0.5 *kg*
D) 2.5 *kg*
E) 3.0 *kg*

Q18.
A 5.0 *m* long uniform ladder (with mass *m* = 12.0 *kg*) leans against a wall at a point 4.0 *m* above a horizontal floor as shown in Fig 9. Assuming the wall is frictionless (but the floor is not), determine the normal force exerted on the ladder by the wall.

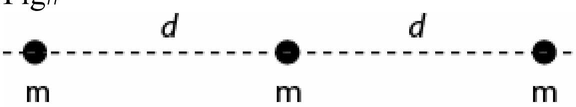
Fig#



A) 44 *N*
B) 59 *N*
C) 120 *N*
D) 160 *N*
E) 89 *N*

Q19.
Three identical particles each of mass *m* are placed on a straight line separated by a distance *d* as shown in Fig. 10. To remove the particle at the center to a point far away (where $U = 0$), the work that must be done by an external agent is given by:

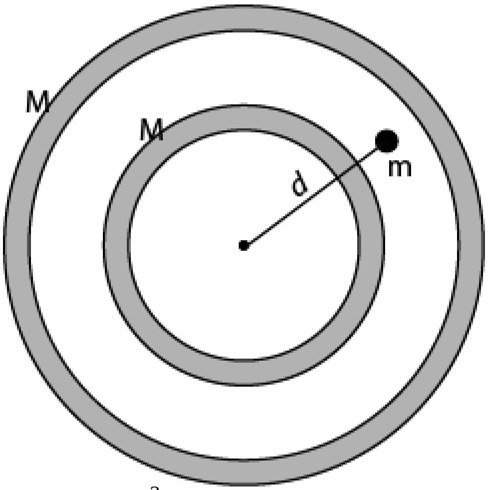
Fig#



A) $2Gm^2/d$
B) $4Gm^2/d$
C) $-Gm^2/d$
D) $-4Gm^2/d$
E) zero

Q20.
Two uniform concentric spherical shells each of mass *M* are shown in Fig. 11. The magnitude of the gravitational force exerted by the shells on a point particle of mass *m* located a distance *d* from the center, outside the inner shell and inside the outer shell, is:

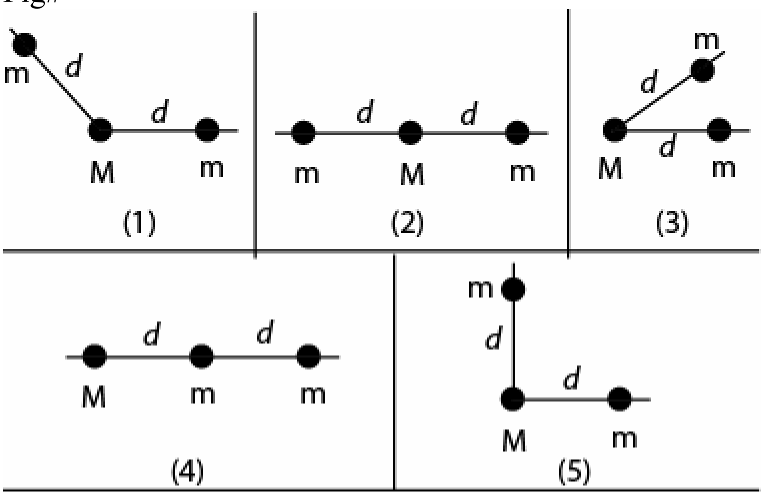
Fig#



A) GMm/d^2
B) $2GMm/d^2$
C) $GMm/(2d^2)$
D) $4GMm/d^2$
E) zero

Q21.
Fig. 12 shows five configurations of three particles, two of which have mass *m* and the other one has mass *M*. The configuration with the least (minimum) gravitational force on *M*, due to the other two particles is:

Fig#



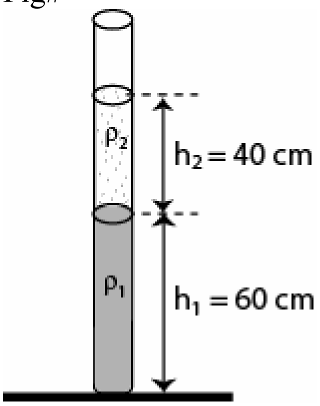
A) 2
B) 1
C) 3
D) 4
E) 5

Q22.
A satellite of mass *m* and kinetic energy *K* is in a circular orbit around a planet of mass *M*. The gravitational potential energy of this satellite-planet system is:

A) $-2K$
B) $-K/2$
C) $K/2$
D) $-K$
E) $4K$

Q23.
The open vertical tube in Fig. 13 contains two liquids of densities $\rho_1 = 1000\ kg/m^3$ and $\rho_2 = 800\ kg/m^3$, which do not mix. Find the gauge pressure (pressure due to the liquids only) at the bottom of the tube.

Fig#



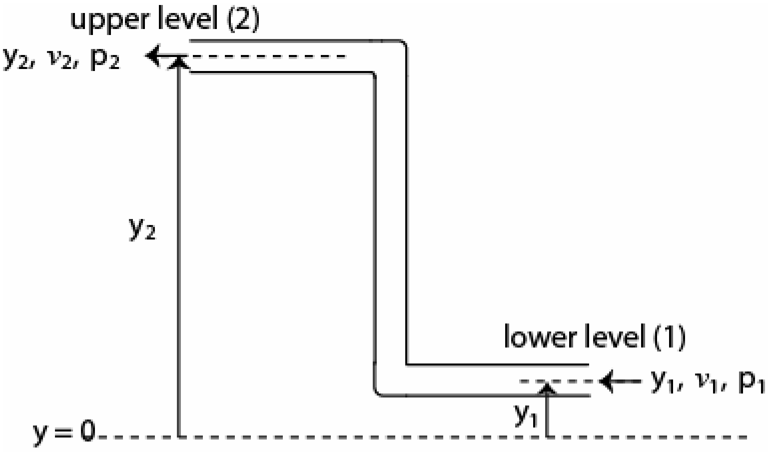
A) 9000 Pa
B) 8000 Pa
C) 7000 Pa
D) 6000 Pa
E) 18000 Pa

Q24.
An Aluminum block of density 2.70 g/cm^3 has a weight W in air and has a weight W_{app} in water when completely submerged. If ($W- W_{app}$) is equal to 196 N, the volume of the block is:

A) 0.020 m^3
B) 0.010 m^3
C) 0.030 m^3
D) 0.040 m^3
E) 0.050 m^3

Q25.
Water is pumped through a hose of uniform cross-section as shown in Fig. 14, from the lower level (1) to the upper level (2). Which of the following expresses the correct relationship between velocity and pressure at the two levels?

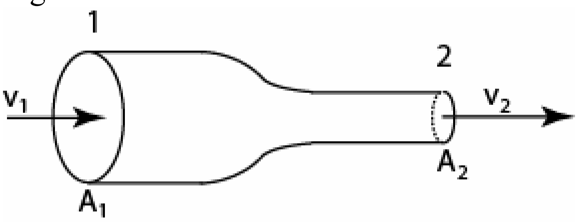
Fig#



A) $v_1 = v_2$ and $p_2 < p_1$
B) $v_1 = v_2$ and $p_2 = p_1$
C) $v_1 < v_2$ and $p_2 < p_1$
D) $v_1 = v_2$ and $p_2 > p_1$
E) $v_1 > v_2$ and $p_2 > p_1$

Q26.
Water flows through a horizontal tube from point 1 (cross sectional area A_1) to point 2 (cross sectional area A_2), as shown in Fig. 15. If $A_1 = 2A_2$ and $v_1 = 10$ *m/s*, the change in the kinetic energy (ΔK) of 1.0 m^3 of water in moving from point 1 to point 2 is:

Fig#



A) 1.5×10^5 *J*
B) 1.0×10^5 *J*
C) zero
D) 2.5×10^5 *J*
E) 3.0×10^5 *J*

Q27.
A block-spring system is oscillating with amplitude x_m. The kinetic energy of the block is equal to the potential energy stored in the spring only when the displacement is:

A) $\pm x_m / \sqrt{2}$
B) zero
C). $\pm x_m / 4$
D) .) $\pm x_m / 2$
E) $2 x_m$

Q28.
A block attached to a spring undergoes a simple harmonic motion on a horizontal frictionless surface. Its mechanical energy is 40 *J*. When the displacement is half the amplitude, the kinetic energy is:

A) 30 *J*
B) zero
C) 15 *J*
D) 25 *J*
E) 40 *J*

Q29.
A 3 *kg* block, attached to a spring, executes simple harmonic motion with a displacement given by $x = 2\cos(50t)$ where *x* is in meters and *t* is in seconds. The spring constant of the spring is:

A) 7500 N/m
B) 10 N/m
C) 100 N/m
D) 250 N/m
E) zero

Q30.
A weight suspended from an ideal spring oscillates up and down with a period *T*. If the amplitude of the oscillation is doubled, the period will be:

A) T
B) $T / 4$
C) $2\,T$
D) $T / 2$
E) $4\,T$