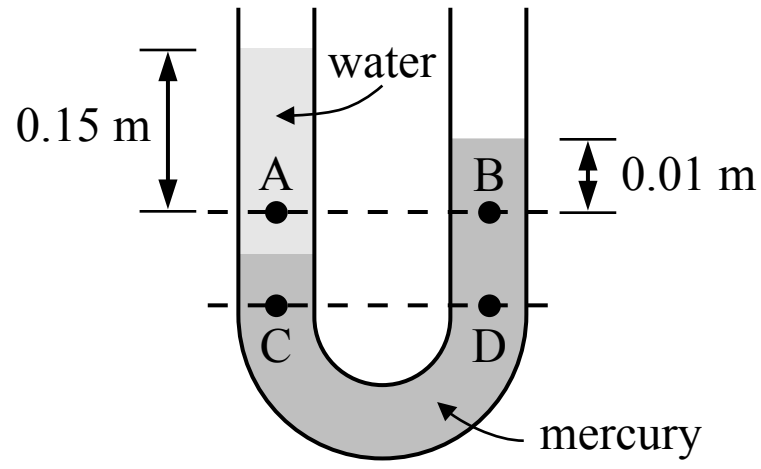
MCQ Practice Test 1

Section I: Multiple-Choice
Time: 80 minutes
40 Questions

Note: To simplify calculations, you may use $g = 10$ m/s² in all problems.

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case.



Note: Figure not drawn to scale.

1. A tube contains a volume of water and a volume of mercury as shown in the figure above. Both ends of the tube are open. Points A and B are at the same level and points C and D are at the same level. The distance between points A and B and the surface of the liquids are shown. Which of the following correctly relates the gauge pressures at the points shown? The density of the water is 1,000 kg/m³ and the density of the mercury is 13,600 kg/m³.

(A)

P_A and P_B	P_C and P_D
$P_A > P_B$	$P_C > P_D$

(B)

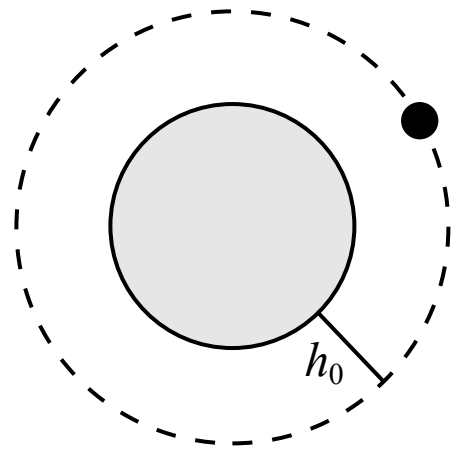
P_A and P_B	P_C and P_D
$P_A > P_B$	$P_C = P_D$

(C)

P_A and P_B	P_C and P_D
$P_A = P_B$	$P_C = P_D$

(D)

P_A and P_B	P_C and P_D
$P_A = P_B$	$P_C > P_D$



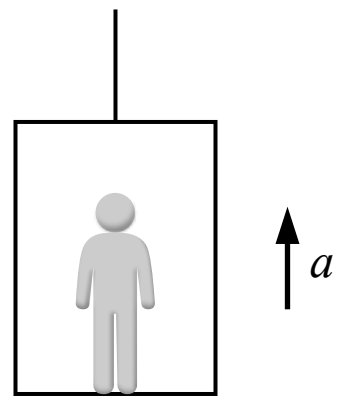
2. A satellite is in a circular orbit around the earth and moves at a constant speed. If the height of the orbit above the surface of the earth increased (and the orbit remained circular) the kinetic energy of the satellite would

   (A) decrease

   (B) increase

   (C) not change

   (D) a change in the kinetic energy cannot be determined



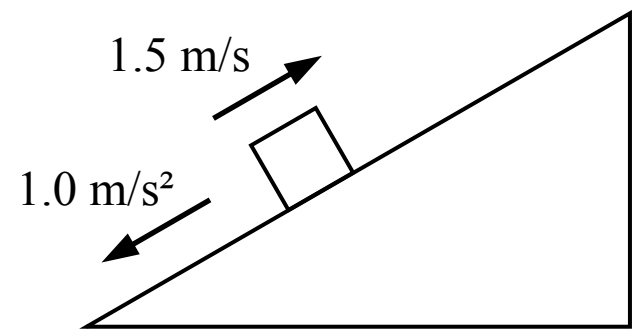
3. A person is standing in an elevator which is accelerating upwards. Which of the following is true of the person's apparent weight?

   (A) The person's apparent weight is zero

   (B) The person's apparent weight is equal to the person's weight

   (C) The person's apparent weight is less than the person's weight, but is not zero

   (D) The person's apparent weight is greater than the person's weight



4. A block is sliding on an incline with negligible friction as shown in the figure above. At time $t = 0$ s the block is moving up the incline with a speed of 1.5 m/s. The magnitude of the acceleration of the block is a constant 1.0 m/s² down the incline. At $t = 3$ s, what is the direction of the block's motion and is the speed increasing or decreasing?

(A)

Direction of motion	Speed
Down the incline	Decreasing

(B)

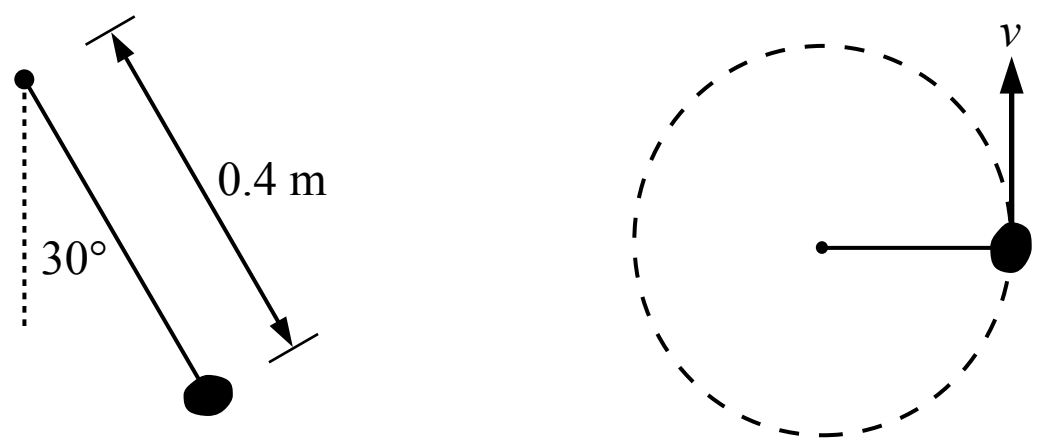
Direction of motion	Speed
Up the incline	Decreasing

(C)

Direction of motion	Speed
Down the incline	Increasing

(D)

Direction of motion	Speed
Up the incline	Increasing



Side view Top view

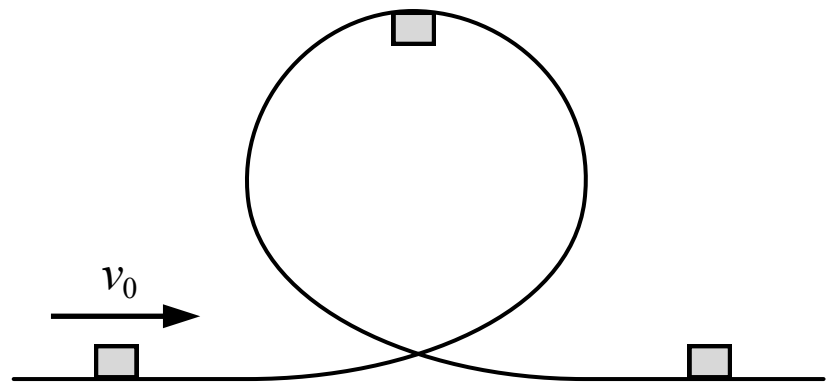
5. A rock is attached to a 0.4 m long string and is swung through the air so that the path of the rock follows a horizontal circle as shown in the top view figure above. The string makes a 30° angle with the vertical as shown in the side view figure. The rock completes one revolution per second. The speed of the rock is most nearly

(A) 0.6 m/s

(B) 1.3 m/s

(C) 2.2 m/s

(D) 2.5 m/s



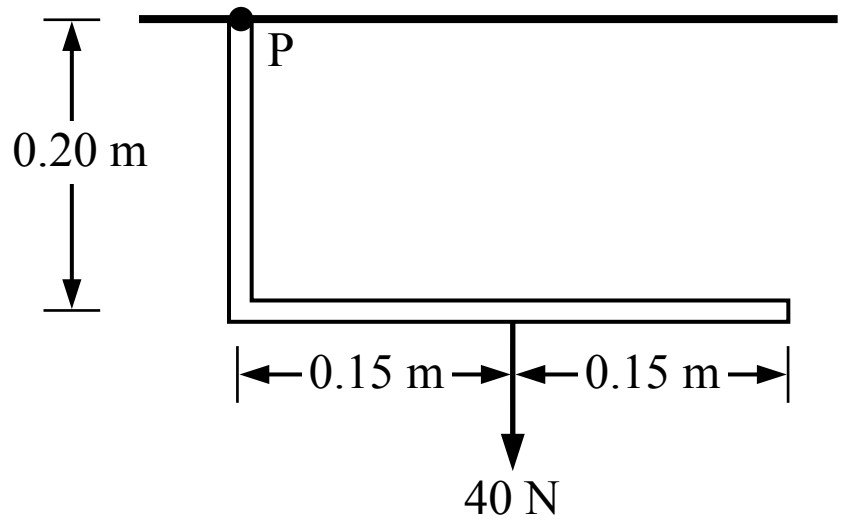
6. A small block slides along a frictionless track with a vertical loop as shown in the figure above. The block is not attached to the track in any way, but its initial velocity is great enough that it moves through the loop without losing contact with the track. What is the direction of the force exerted on the block by the track when the block is at the top of the loop?

(A) 

(B) 

(C) 

(D) 



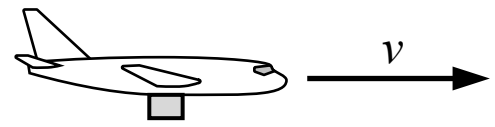
7. A thin pipe with negligible mass is attached to the ceiling at point P as shown in the figure above. The torque generated at point P by the 40 N force is

(A) 14 N·m

(B) 12 N·m

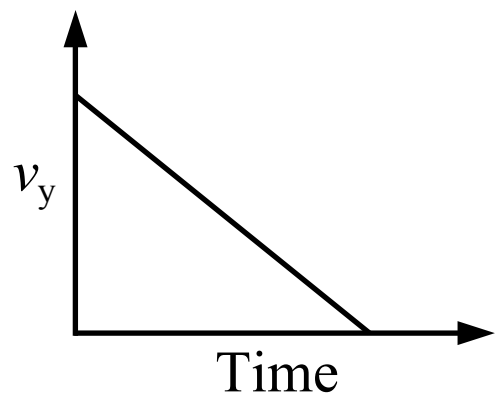
(C) 8 N·m

(D) 6 N·m

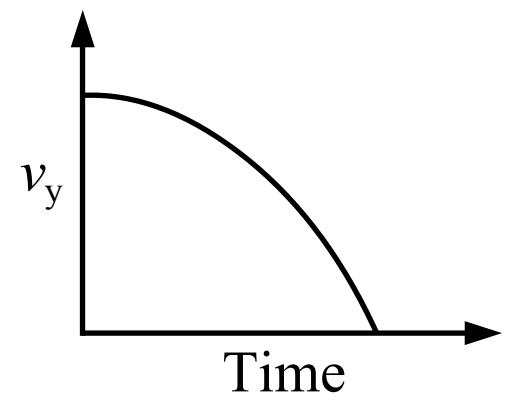


8. A plane is flying at a constant horizontal speed and is carrying a box as shown in the figure above. It then releases the box which falls through the air and lands on the ground. Ignoring air resistance, which of the following graphs shows the magnitude of the vertical velocity of the box before it lands on the ground?

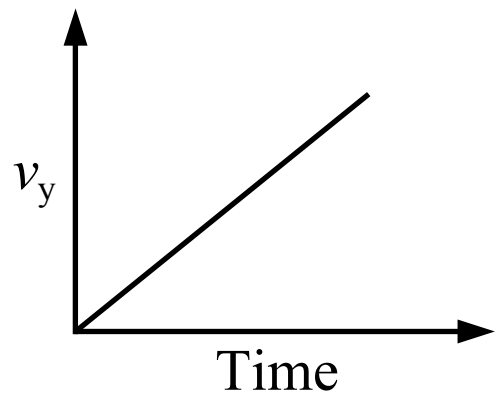
(A)



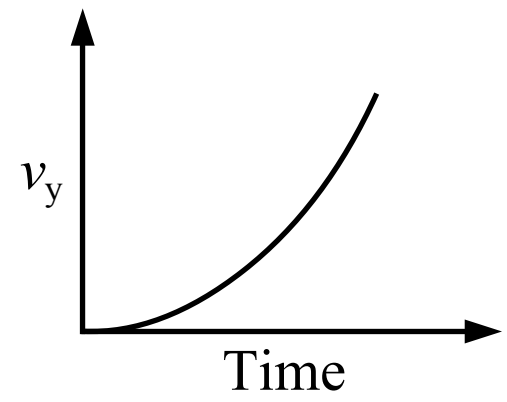
(B)

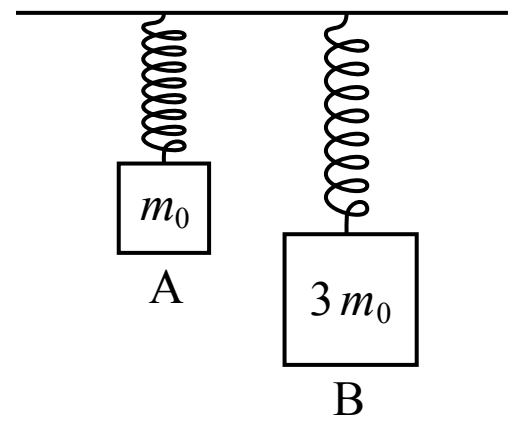


(C)



(D)





9. Two identical springs are suspended from the ceiling and then two blocks with different masses are attached to the bottom of the springs. How does the spring potential energy of the spring-block A system, $U_{\text{sp A}}$, compare to the spring potential energy of the spring-block B system, $U_{\text{sp B}}$?

(A) $U_{\text{sp B}} = 9\,U_{\text{sp A}}$

(B) $U_{\text{sp B}} = 3\,U_{\text{sp A}}$

(C) $U_{\text{sp B}} = U_{\text{sp A}}$

(D) $U_{\text{sp B}} = U_{\text{sp A}} / 3$

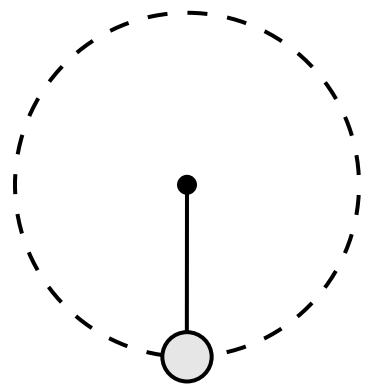
10. Two blocks are on a surface with negligible friction. Block 1 slides towards block 2 and they stick together and move to the right. During the collision the speed of the center of mass of the system

    (A) increases

    (B) does not change

    (C) decreases

    (D) the change in the speed of the center of mass of the system cannot be determined



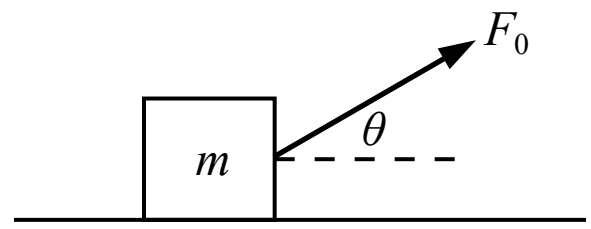
11. A sphere is attached to a string and swings around in a vertical circle at a constant speed. Which of the following shows the direction of the net force acting on the sphere when it is at the position shown in the figure above?

    (A) 

    (B) 

    (C) 

    (D) 



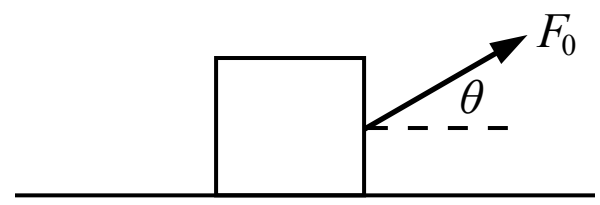
12. A force is exerted on a block as shown in the figure above. The block accelerates horizontally along the floor and the coefficient of kinetic friction between the block and the floor is μ_k. Which of the following is a correct expression for the acceleration of the block?

(A) $\dfrac{F_0\cos(\theta) - \mu_k(mg - F_0\sin(\theta))}{m}$

(B) $\dfrac{F_0\cos(\theta) - \mu_k mg}{m}$

(C) $\dfrac{F_0\sin(\theta) - \mu_k(F_0\sin(\theta) - mg)}{m}$

(D) $\dfrac{F_0\sin(\theta) - \mu_k mg}{m}$



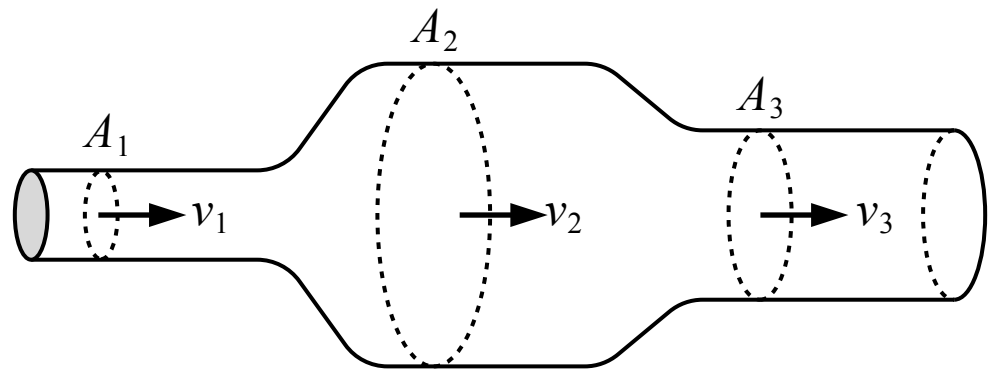
13. A force with a magnitude of F_0 is exerted on a block as shown in the figure above. There is a friction force between the block and the floor with a magnitude of f. If the block remains in contact with the floor, the net force acting on block is

(A) $F_0\cos(\theta) + f$

(B) $F_0\sin(\theta) - mg$

(C) $F_0 - f$

(D) $F_0\cos(\theta) - f$



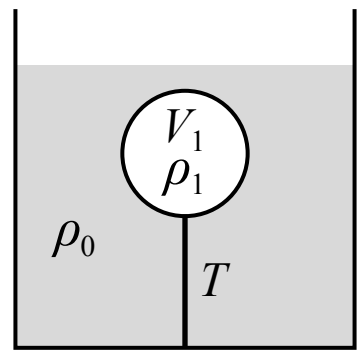
14. An ideal fluid is flowing through the tube shown in the figure above. Which of the following correctly ranks the speed of the fluid through the three areas shown above?

(A) $v_1 < v_3 < v_2$

(B) $v_1 = v_2 = v_3$

(C) $v_2 < (v_1 = v_3)$

(D) $v_2 < v_3 < v_1$



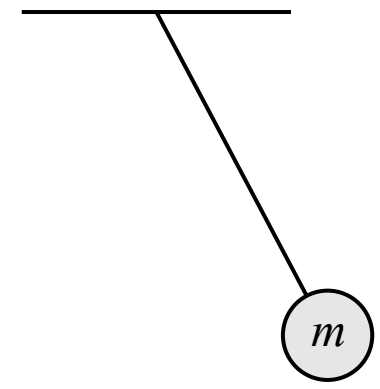
15. A ball is submerged and floating at rest in a liquid as shown in the figure above. The ball is attached to the bottom of the container by a string. The density of the liquid is ρ_0 , the density of the ball is ρ_1 and the volume of the ball is V_1 . Which of the following is a correct expression for the tension in the string T ?

(A) $\rho_1 V_1 g + \rho_0 V_1 g$

(B) $\rho_1 V_1 g - \rho_0 V_1 g$

(C) $\rho_0 V_1 g - \rho_1 V_1 g$

(D) $\rho_0 V_1 g$



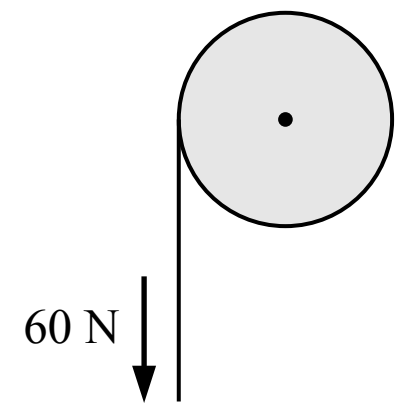
16. A pendulum consists of a sphere of mass m attached to a string with negligible mass. As the pendulum swings back and forth, which of the following statements is true?

    (A) The total kinetic energy of the sphere-earth system is constant

    (B) The total energy of the sphere-earth system is constant

    (C) The total gravitational potential energy of the sphere-earth system is constant

    (D) All of the above



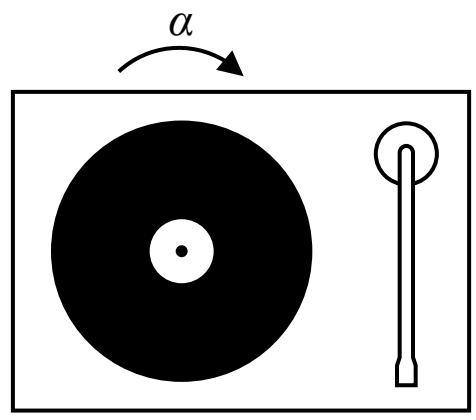
17. A string with negligible mass is wrapped around the outside of a pulley which has a radius of 0.1 m. The pulley is initially at rest when a constant 60 N force is applied to the string. The angular momentum of the pulley after a period of 2 s is most nearly

    (A) 0

    (B) 12 kg·m²/s

    (C) 6 kg·m²/s

    (D) Cannot be determined



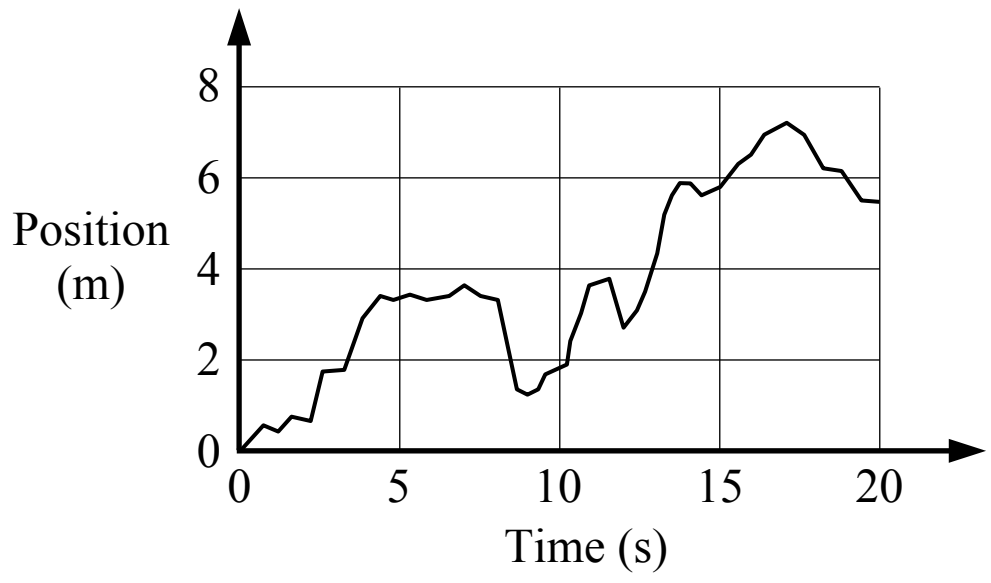
18. A vinyl record begins at rest and then experiences an angular acceleration of α. What is the angular displacement of the record after a period of 3 seconds?

(A) 6α

(B) 9α

(C) 3α

(D) $9\alpha/2$



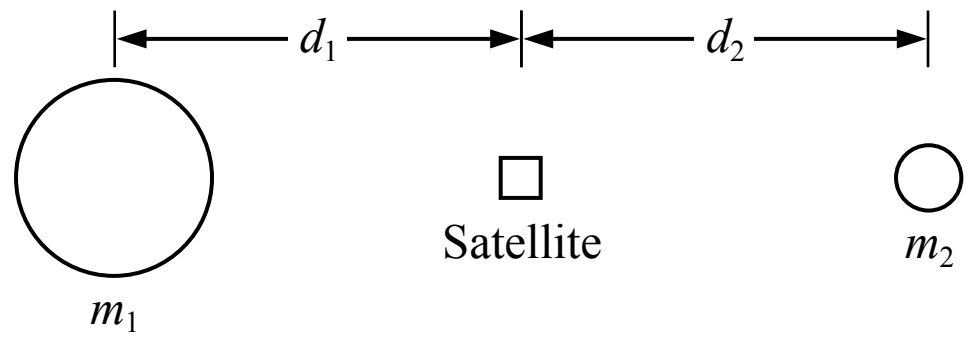
19. A group of students want to make a graph that shows their position over time while walking. They set up a detector in a hallway which measures their position relative to the detector, and they take turns walking in the hallway. One student's motion is shown in the graph above. Which of the following is the best approximation of the student's average velocity for the period of time between 10 seconds and 15 seconds?

(A) 0.8 m/s

(B) 0.4 m/s

(C) 1.2 m/s

(D) 1.4 m/s



Note: Figure not drawn to scale.

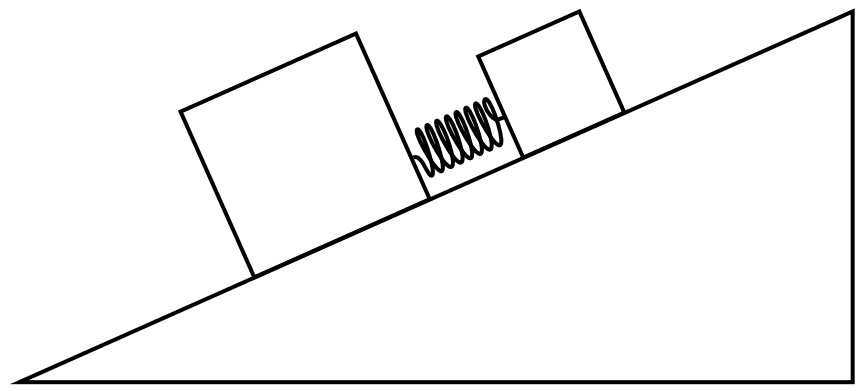
20. A satellite is in line with a planet of mass m_1 and a moon with a mass of m_2 as shown in the figure above, and m_1 is greater than m_2. The net force on the satellite is zero at this position. How does the distance between the satellite and the center of the planet, d_1, compare to the distance between the satellite and the center of the moon, d_2?

(A) $d_1 > d_2$

(B) $d_1 < d_2$

(C) $d_1 = d_2$

(D) Cannot be determined



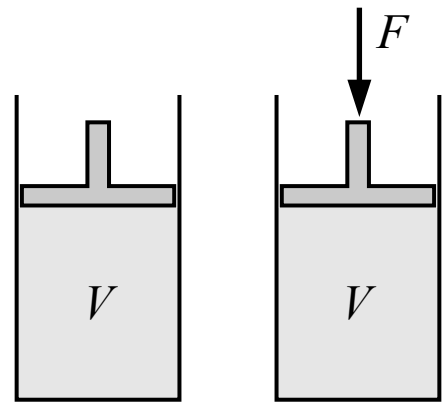
21. Two blocks are connected by a spring and placed on an incline with negligible friction. The blocks are held so that the spring is initially compressed. The blocks are then released from rest and they move apart from each other due to the spring. How does the total momentum of the blocks-spring system change after the blocks are released?

(A) The total momentum decreases

(B) The total momentum increases

(C) The total momentum does not change

(D) Cannot be determined



22. A volume of an unknown fluid is contained in a cylinder below a piston as shown in the figure above. A downwards force is then applied to the piston. If the unknown fluid is a liquid or a gas, which of the following correctly describes how the volume of the fluid changes when the force is applied?

(A)

Liquid volume	Gas volume
Decreases	Does not change

(B)

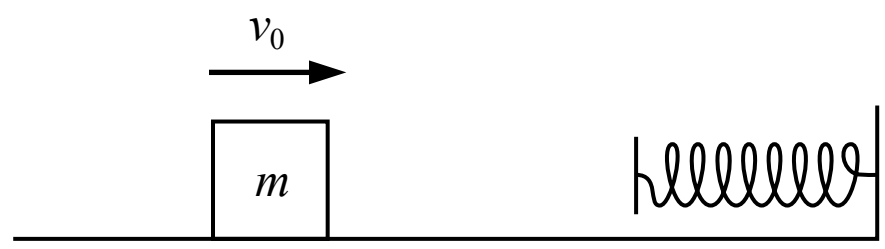
Liquid volume	Gas volume
Does not change	Does not change

(C)

Liquid volume	Gas volume
Decreases	Decreases

(D)

Liquid volume	Gas volume
Does not change	Decreases



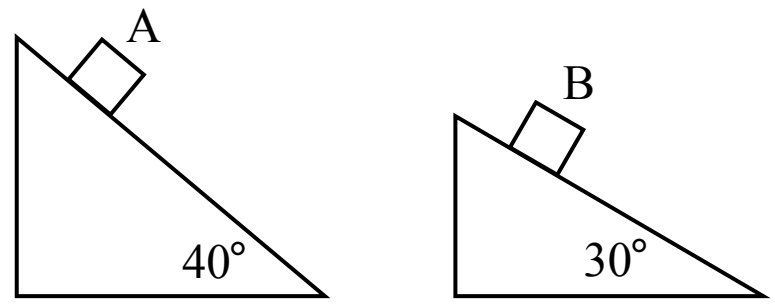
23. A block is sliding across a surface where the friction is not negligible. The block has an initial speed of v_0 at time t_0. The block then collides with a spring and momentarily comes to a stop at time t_1. Which of the following is true about the block-spring system from time t_0 to time t_1?

(A) The spring does positive work on the system

(B) The total energy of the system is constant

(C) The spring does negative work on the system

(D) The total energy of the system decreases



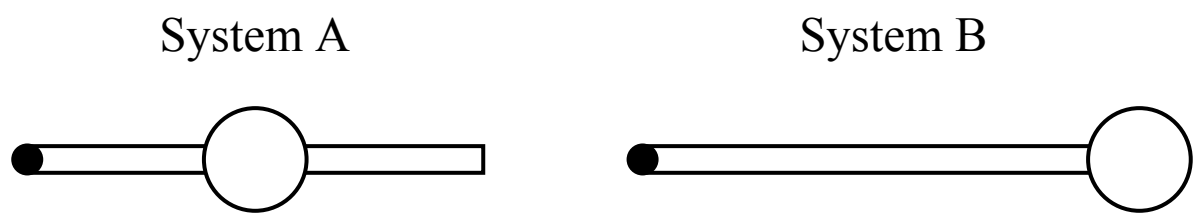
24. Two identical blocks are sliding down two inclines as shown in the figure above. The coefficient of kinetic friction is the same for both inclines. Which block experiences a friction force with a greater magnitude?

(A) Block A

(B) Block B

(C) The blocks experience friction forces with equal magnitudes

(D) Cannot be determined



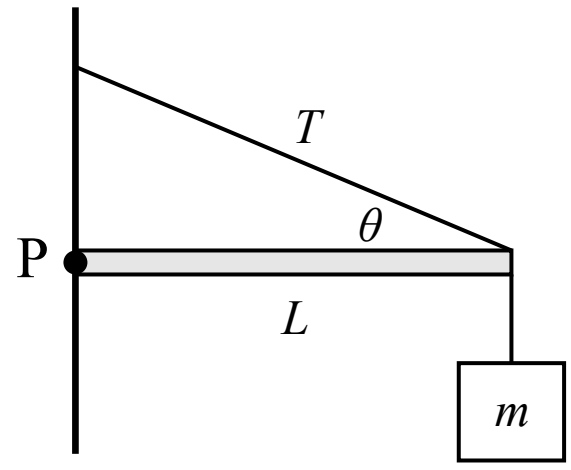
25. Two systems consist of identical rods and identical spheres which are free to rotate about the left end of the rod. The sphere in system A is located at the center of the rod, and the sphere in system B is located at the end of the rod. If torques are applied to the systems so that both systems rotate with the same angular speed, which system will have a greater rotational kinetic energy?

(A) The systems will have the same rotational kinetic energy

(B) System A

(C) System B

(D) Cannot be determined



26. A horizontal pole with a length of L and negligible mass is attached to a wall at point P where it is free to rotate. At the other end of the pole, a block of mass m is suspended by a string with negligible mass and a rope with a tension of T and negligible mass connects the pole and the wall at an angle as shown in the figure above. The magnitude of the net torque acting on the pole about point P is

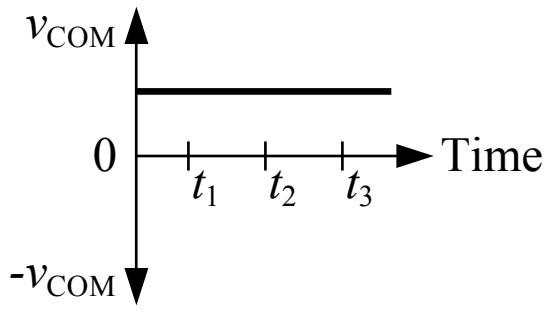
(A) $LT\sin(\theta) + Lmg$

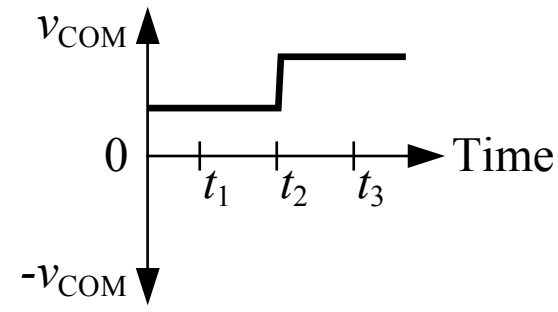
(B) $LT\cos(\theta) - Lmg$

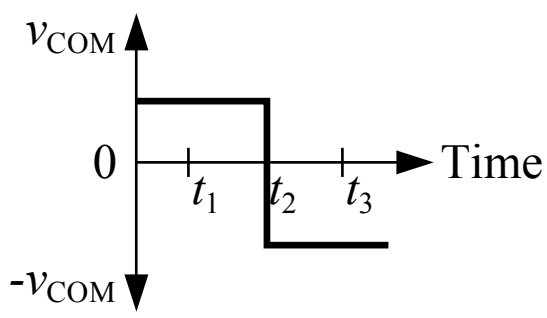
(C) $LT\sin(\theta) - Lmg$

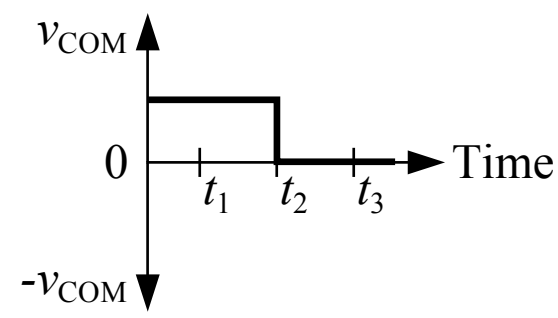
(D) $T\sin(\theta) - mg$

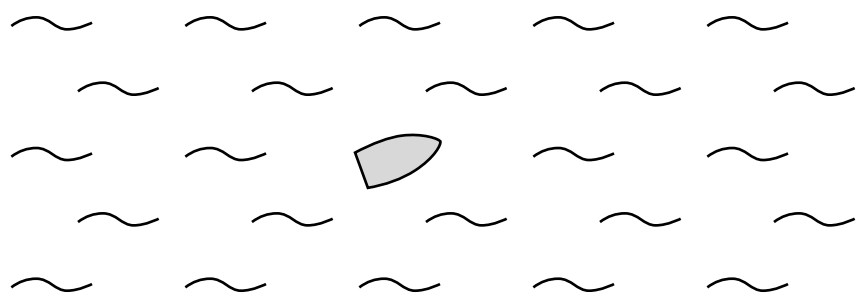
27. Two blocks are connected by a compressed spring and are sliding together to the right on a surface with negligible friction at time t_1. Some time later at time t_2 the spring expands and pushes the blocks apart. Some time later at time t_3 the blocks are moving in opposite directions. Which of the following could be a graph of the velocity of the center of mass of the blocks-spring system if right is considered the positive direction?

(A)


(B)


(C)


(D)




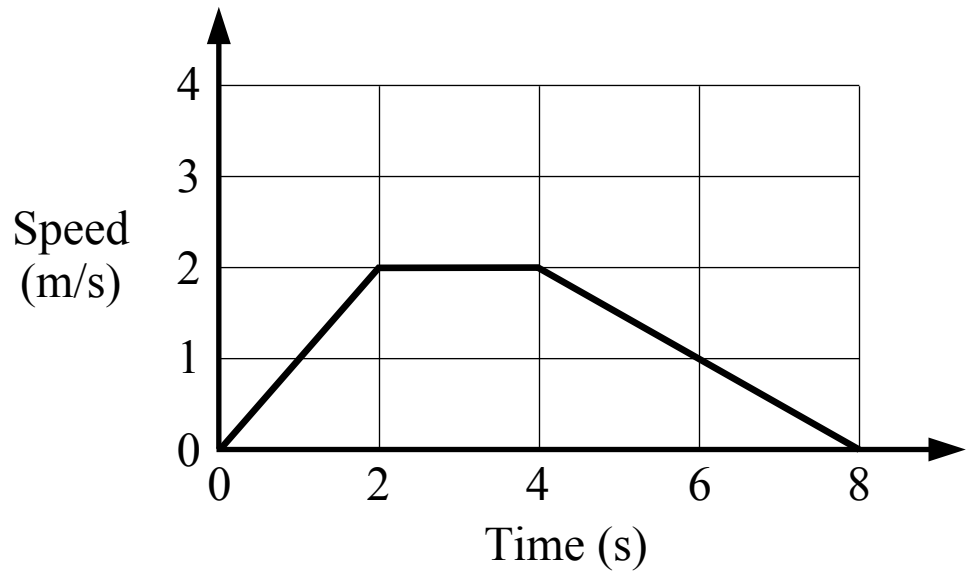
28. A boat is in the middle of a lake as shown in the figure above. The boat moves 18 m in a straight line with an unknown direction, and then it moves 25 m in a straight line with an unknown direction. Which of the following cannot be the magnitude of the boat's total displacement?

    (A) 43 m

    (B) 18 m

    (C) 25 m

    (D) 5 m



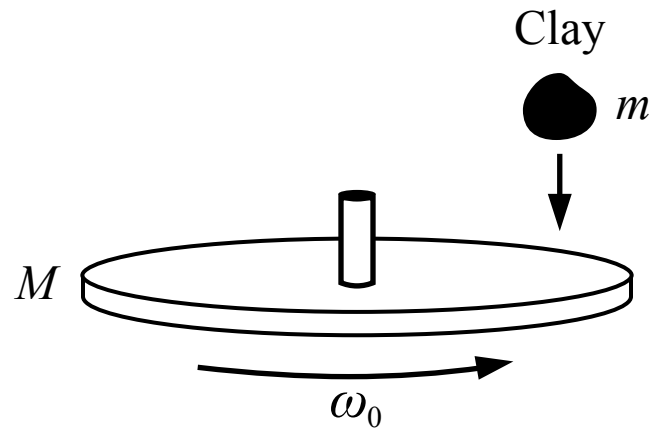
29. A cart moves on a horizontal surface and its motion is shown in the above graph. Which of the following statements about the motion of the cart is most accurate?

    (A) There must be no horizontal forces on the cart between 0 s and 2 s

    (B) There must be no horizontal forces on the cart between 2 s and 4 s

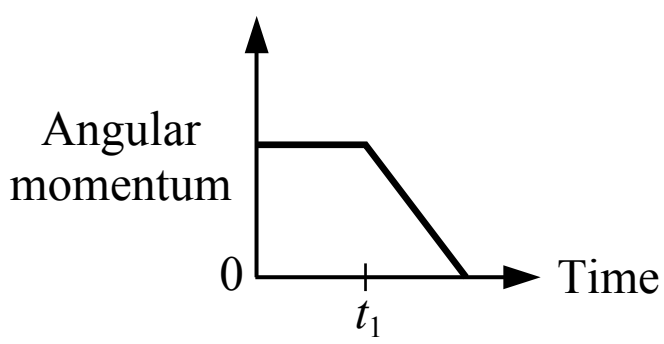
    (C) There may be horizontal forces on the cart between 2 s and 4 s

    (D) None of the above

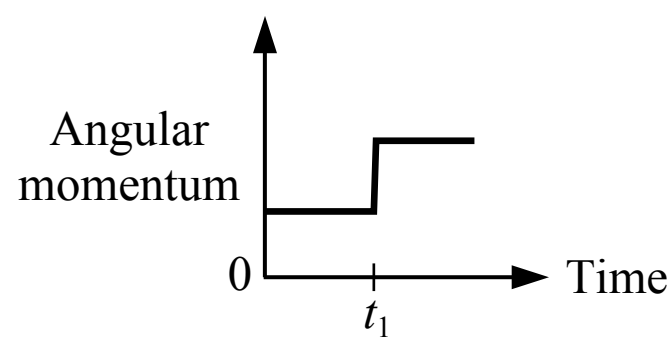


30. A large wheel is free to spin about an axle passing through its center without friction. The wheel is rotating with a constant angular speed of ω_0 when a ball of clay is dropped from rest onto the wheel from above and the clay immediately sticks to the wheel at time t_1. Which of the following graphs show the angular momentum of the wheel-clay system about an axis passing through the axle?

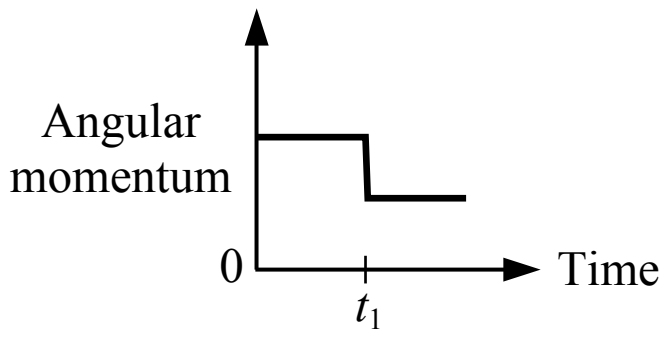
(A)



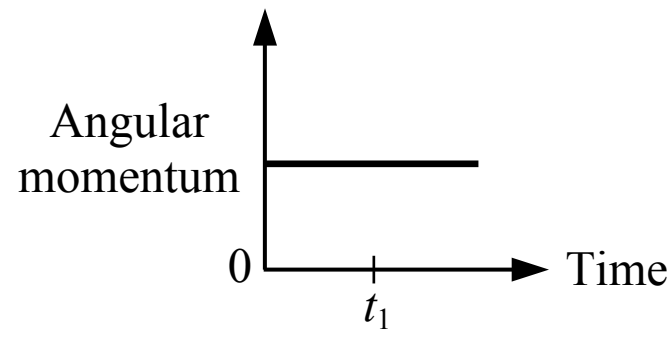
(B)

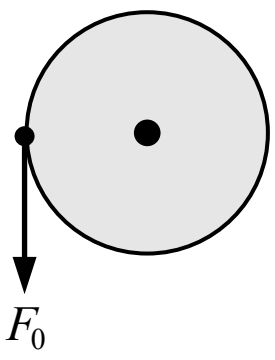


(C)



(D)





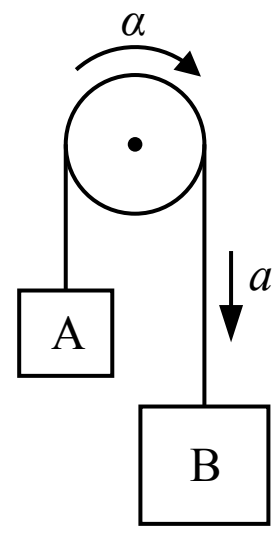
31. A wheel is initially spinning freely about its center in the clockwise direction with a constant angular speed. A force is then applied to the wheel as shown in the figure above. At the moment the force is applied, which of the following is true about the angular acceleration of the wheel?

(A) The angular acceleration is in the clockwise direction

(B) The angular acceleration is in the counterclockwise direction

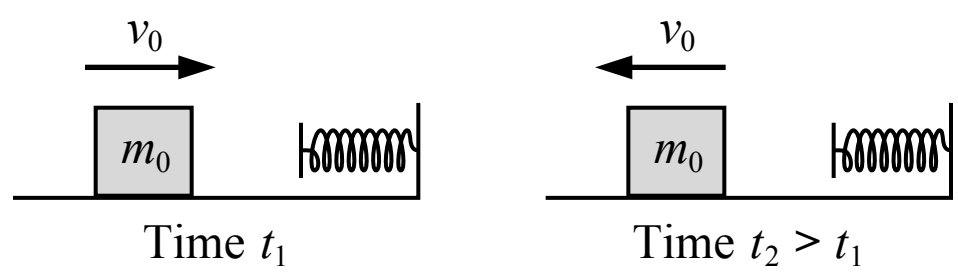
(C) The angular acceleration is zero

(D) None of the above can be determined



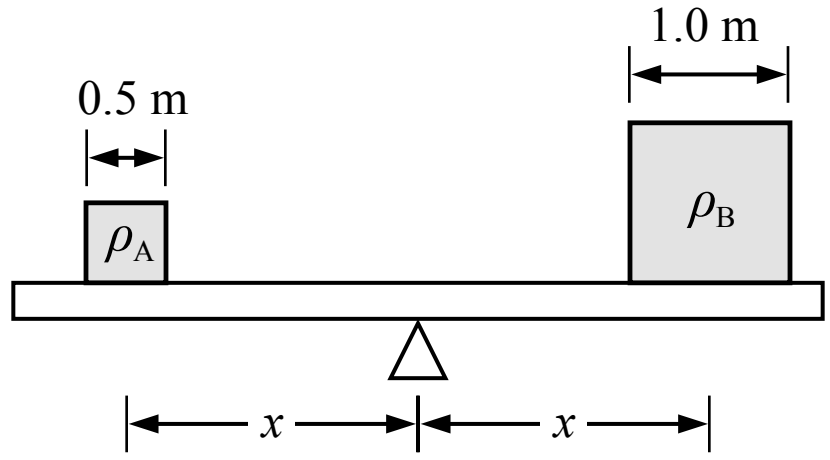
32. Two blocks are connected by a cable that is wrapped around a pulley as shown in the figure above. Block B has a greater mass than block A so the blocks accelerate and the pulley experiences an angular acceleration (the cable turns the pulley without slipping). If the diameter of the pulley is 0.2 m and the angular acceleration of the pulley is 15 rad/s², the magnitude of the acceleration of the blocks is most nearly

(A) 0.75 m/s²
(B) 150 m/s²
(C) 1.5 m/s²
(D) 3.0 m/s²



33. A block is sliding to the right on a surface with negligible friction with a speed of v_0 at time t_1. The block then compresses a spring and reverses direction. The block is moving to the left with the same speed of v_0 at a later time t_2. The magnitude of the impulse exerted on the block by the spring is

(A) $2\,m_0\,v_0$
(B) $m_0\,v_0$
(C) $m_0\,v_0/2$
(D) 0



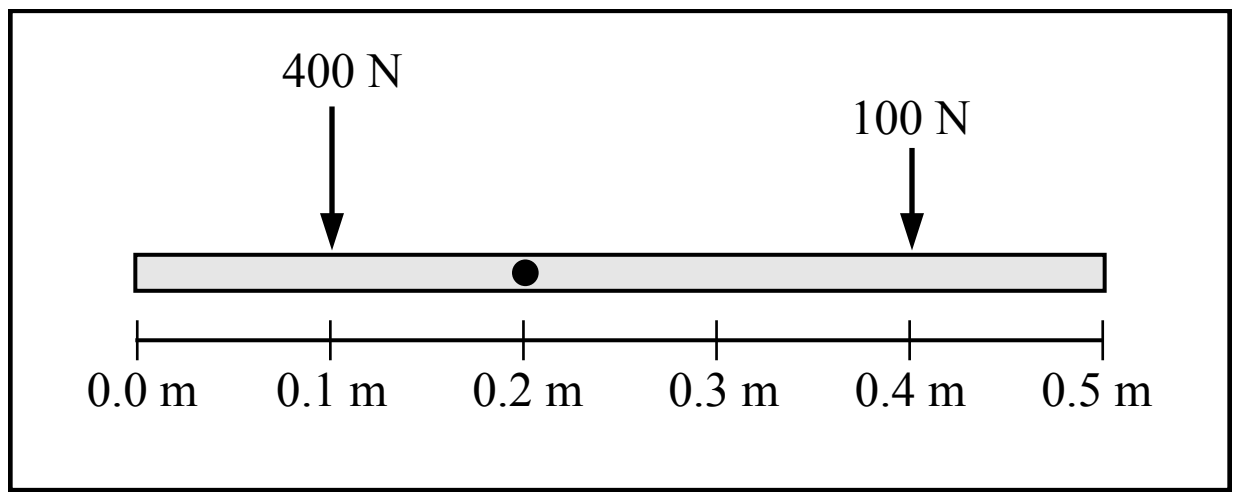
34. Two cubes are balanced on a beam which is at rest as shown in the figure above. The centers of mass of each cube are the same distance from the pivot point of the beam. Cube A has a side length of 0.5 m and cube B has a side length of 1.0 m. What is the ratio of the density of cube A to the density of cube B, ρ_A/ρ_B?

(A) 1/8

(B) 4

(C) 8

(D) 2



Top view

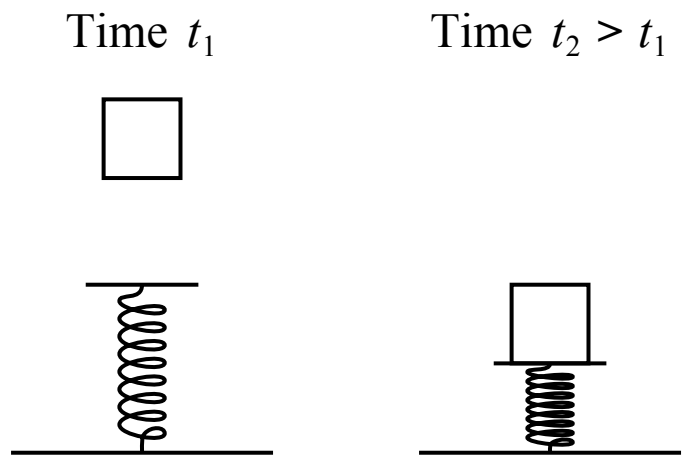
35. A rod is resting on a table with negligible friction and is pinned so it is free to rotate about a point 0.2 m from the left end of the rod. Two horizontal forces are applied to the beam as shown in the figure above, which is a top-down view of the rod on the table. The rotational inertia of the beam is 20 kg·m². At the moment the two forces are applied, the magnitude of the angular acceleration of the beam is

(A) 0 rad/s²

(B) 3 rad/s²

(C) 1 rad/s²

(D) 20 rad/s²



36. A block is released from rest at a height above an uncompressed spring at time t_1. The block falls and compresses the spring, and momentarily comes to rest at time t_2. Which of the following correctly compares the total energy of the following systems at time t_1 and time t_2?

(A)

Block System	Block-Earth System	Block-Spring System
$E_1 < E_2$	$E_1 > E_2$	$E_1 < E_2$

(B)

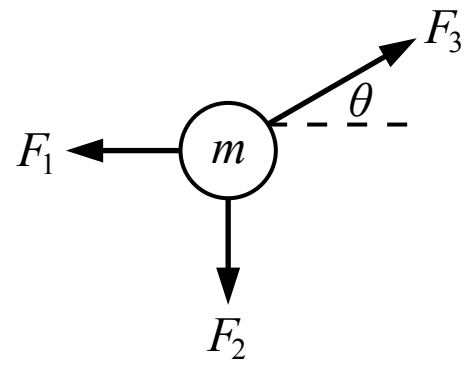
Block System	Block-Earth System	Block-Spring System
$E_1 = E_2$	$E_1 = E_2$	$E_1 = E_2$

(C)

Block System	Block-Earth System	Block-Spring System
$E_1 > E_2$	$E_1 < E_2$	$E_1 > E_2$

(D)

Block System	Block-Earth System	Block-Spring System
$E_1 = E_2$	$E_1 > E_2$	$E_1 < E_2$



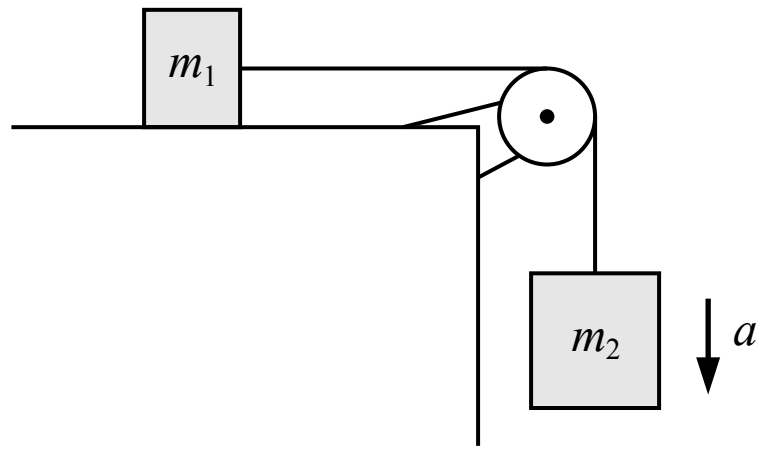
37. Three forces of magnitudes F_1 , F_2 and F_3 are acting on an object of mass m as shown in the figure above. Which of the following represents the magnitude of the object's acceleration?

(A) $\sqrt{\left(\frac{F_3\sin\theta - F_1}{m}\right)^2 + \left(\frac{F_3\cos\theta - F_2}{m}\right)^2}$

(B) $\frac{F_1 + F_2 + F_3}{m}$

(C) $\sqrt{\left(\frac{F_3\cos\theta - F_1}{m}\right)^2 + \left(\frac{F_3\sin\theta - F_2}{m}\right)^2}$

(D) $\frac{F_3\cos\theta - F_1}{m} + \frac{F_3\sin\theta - F_2}{m}$



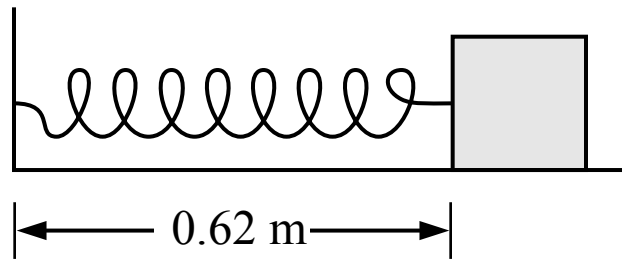
38. Two blocks are connected by a string with negligible mass which passes over a pulley with negligible mass and negligible friction as shown in the figure above. There is negligible friction between the block of mass m_1 and the surface. Which of the following is an expression for the magnitude of the acceleration of the lower block?

(A) g

(B) $\frac{m_2 g}{m_1}$

(C) $\frac{(m_1 + m_2)g}{m_1 + m_2}$

(D) $\frac{m_2 g}{m_1 + m_2}$



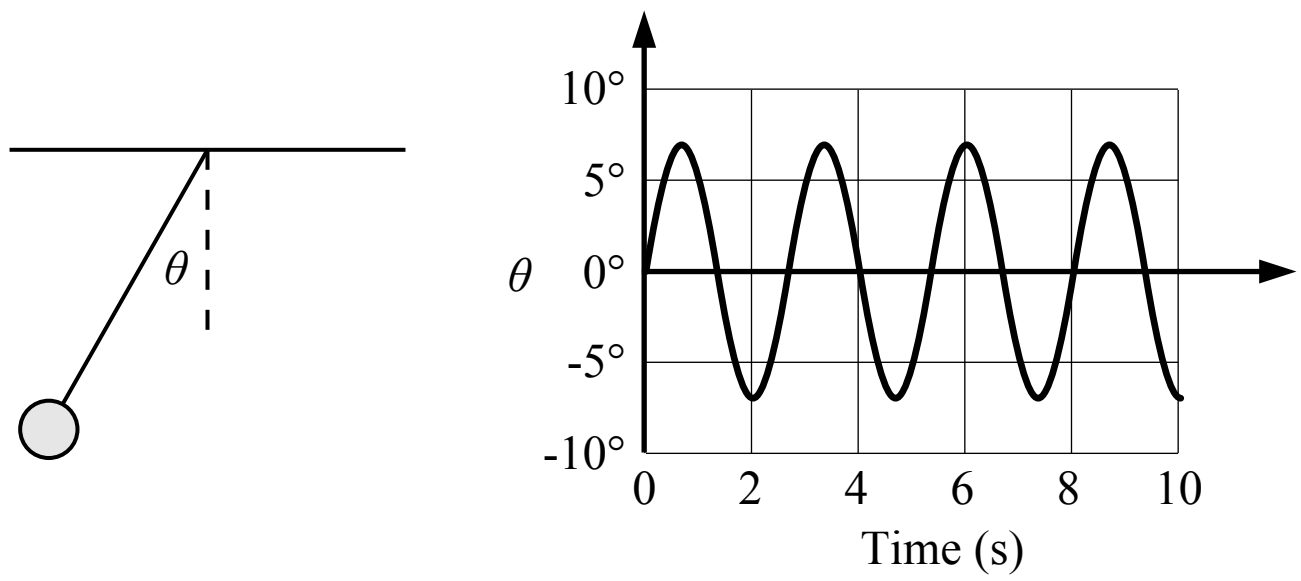
39. A block is attached to a spring which has an unstretched length of 0.68 m. The block is held in the position shown in the figure above. If the block is moved 0.10 m to the right, the magnitude of the spring force on the block

(A) will be greater than the magnitude of the spring force at the position shown

(B) will be less than the magnitude of the spring force at the position shown

(C) will be the same as the magnitude of the spring force at the position shown

(D) cannot be compared to the magnitude of the spring force at the position shown



40. A graph of the angle between a pendulum and the vertical is shown in the figure above. The frequency of the pendulum is most nearly

(A) 0.25 Hz

(B) 0.38 Hz

(C) 1 Hz

(D) 2.67 Hz