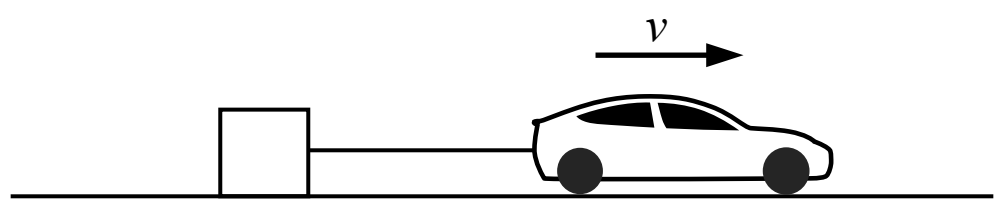
MCQ Practice Test 3

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

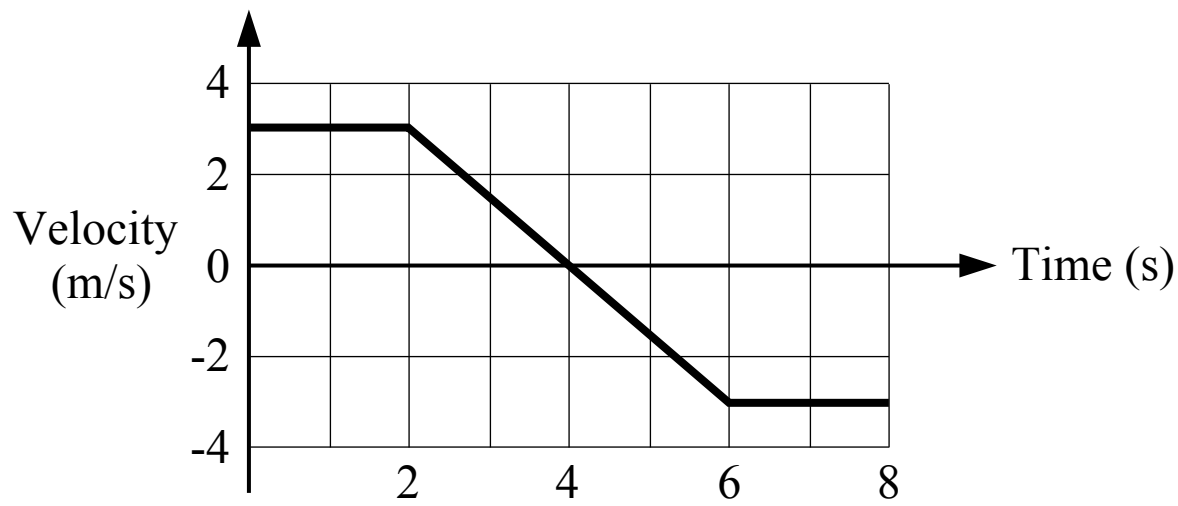
Note: To simplify calculations, you may use $g = 10$ m/s² in all problems.

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.



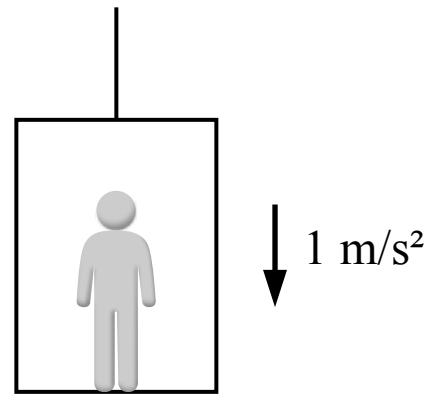
1. A car pulls a large block across the ground where the friction between the block and the ground is not negligble. The car is moving at a constant speed. Which of the following statements is true?

   (A) The force exerted on the block from the car is greater in magnitude than the friction force on the block
   (B) The force exerted on the block from the car is smaller in magnitude than the friction force on the block
   (C) The force exerted on the block from the car is equal in magnitude to the friction force on the block
   (D) The friction force on the block is zero



2. A cart is sliding on a horizontal track and its motion is shown in the figure above. Which of the following statements about the cart's motion is true?

   (A) The cart is not moving between 2 s and 6 s
   (B) The speed of the cart is decreasing between 4 s and 6 s
   (C) The cart is not moving between 0 s and 2 s
   (D) The speed of the cart is increasing between 4 s and 6 s



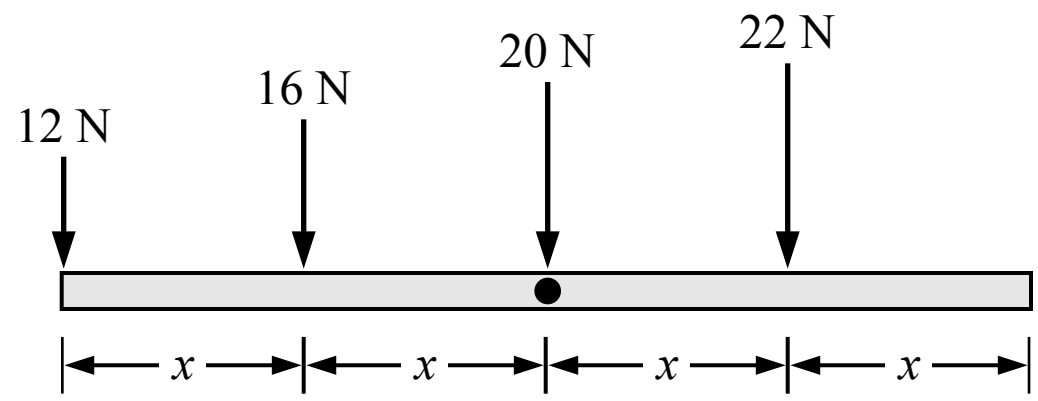
3. A person is standing in an elevator which is accelerating downwards at 1 m/s². Which of the following is true of the net force acting on the person?

   (A) The net force on the person is downwards

   (B) The net force on the person is upwards

   (C) There is no net force acting on the person

   (D) The direction of the net force cannot be determined



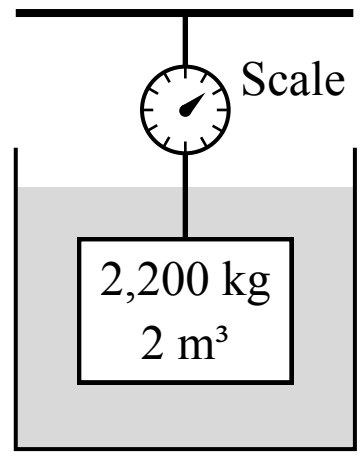
4. Four forces are exerted on a rod which is free to rotate about its center. The forces are applied at evenly spaced distances as shown in the figure above. Which single force, if applied on its own, would cause the rod to rotate with the greatest angular acceleration (magnitude)?

   (A) The 22 N force

   (B) The 12 N force

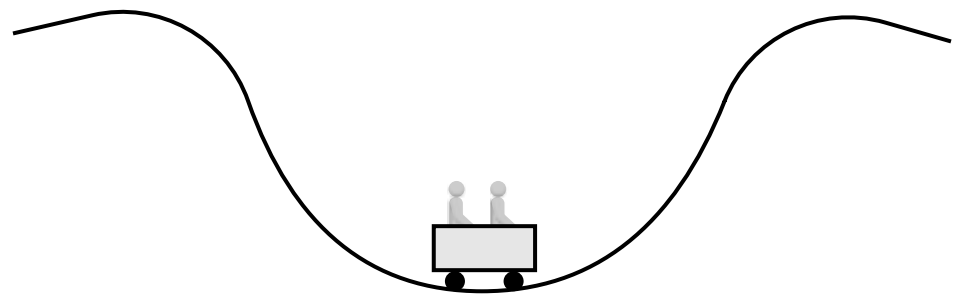
   (C) The 20 N force

   (D) The 16 N force



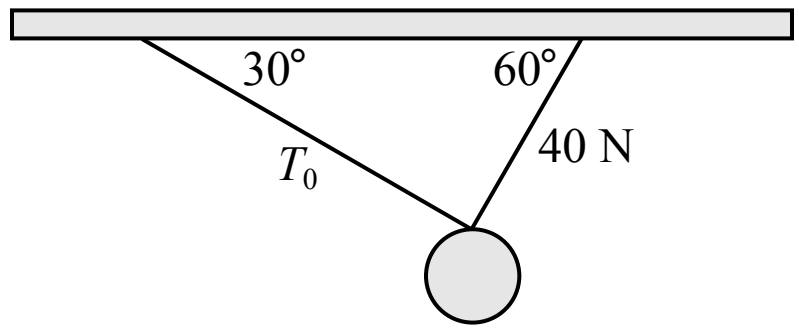
5. A block is suspended from a scale with a string and is fully submerged in a container of water as shown in the figure above. The block has a mass of 2,200 kg and a volume of 2 m³. The density of the water is 1,000 kg/m³. The reading on the scale is

   (A) 20,000 N
   (B) 22,000 N
   (C) 0 N
   (D) 2,000 N



6. Two people are riding a roller coaster and the car enters a dip with a circular arc as shown in the figure above. When the car is at the position shown, the apparent weight of a rider is

   (A) equal to their true weight
   (B) less than their true weight
   (C) greater than their true weight
   (D) a comparison between their apparent weight and true weight cannot be determined



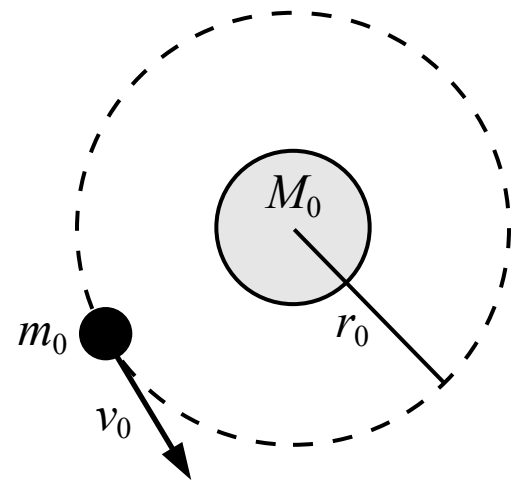
7. A ball is suspended from two cables as shown in the figure above. The ball is at rest and the tension in the cable on the right is 40 N. The tension T_0 in the cable on the left is most nearly

(A) 20 N

(B) 69 N

(C) 23 N

(D) 40 N



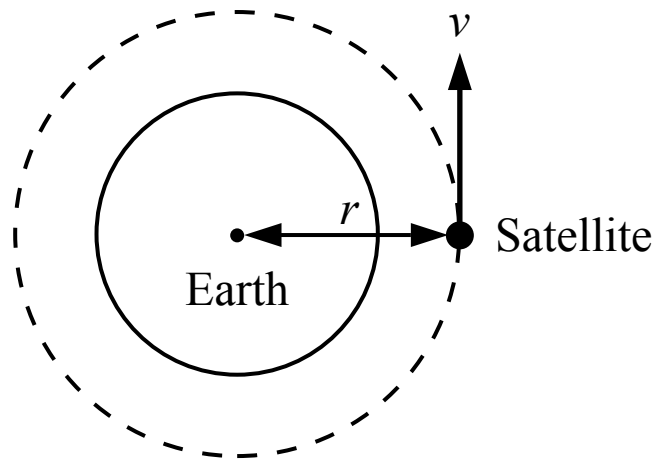
8. A satellite with a mass of m_0 is orbiting a planet with a mass of M_0. The satellite has a speed of v_0 and an orbital radius of r_0. If a second satellite has the same orbital radius but a mass of $2\,m_0$, what is the speed of the second satellite in terms of v_0?

(A) $4\,v_0$

(B) $2\,v_0$

(C) v_0

(D) $v_0 / \sqrt{2}$



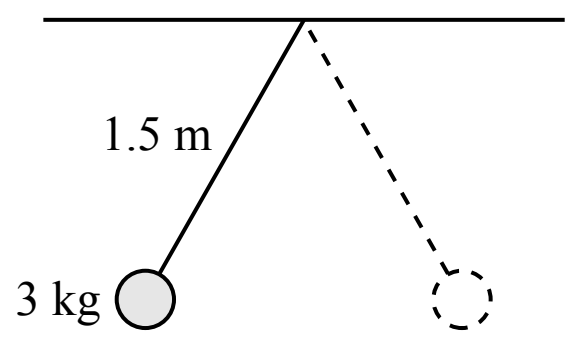
9. A satellite follows a circular orbit around the earth at a constant speed as shown in the figure above. How long does it take to complete one orbit?

(A) $2\pi r$

(B) $\dfrac{r}{v}$

(C) $2\pi rv$

(D) $\dfrac{2\pi r}{v}$



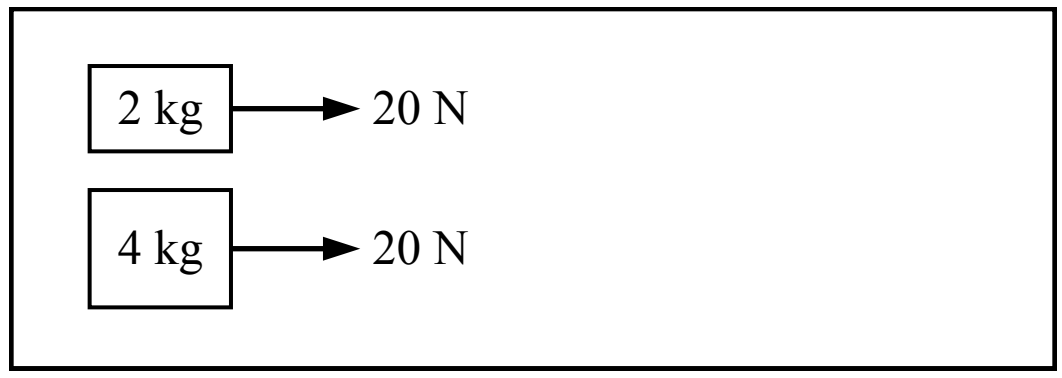
10. A 3 kg mass is attached to a 1.5 m long string with negligible mass as shown in the figure above. The mass is released from rest at the position shown. The time it takes for the mass to swing across to the other side, where the mass is at the same height, is most nearly

(A) 0.2 s

(B) 1.2 s

(C) 8.1 s

(D) 2.4 s



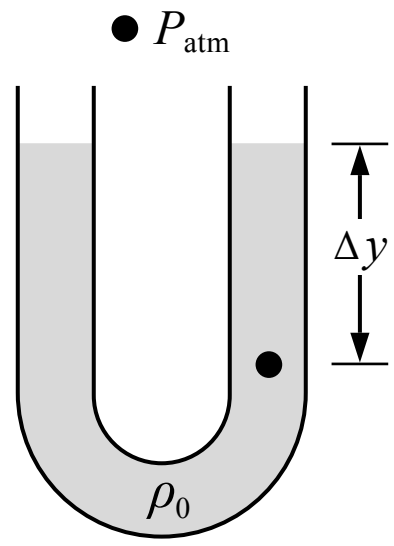
11. Two blocks are sitting on a table where the friction between the blocks and the table is negligible. A 20 N force is then exerted on each block for a period of 5 seconds. Which block experiences a greater impulse during that time?

(A) The 2 kg block

(B) The 4 kg block

(C) The blocks experience the same impulse

(D) Cannot be determined



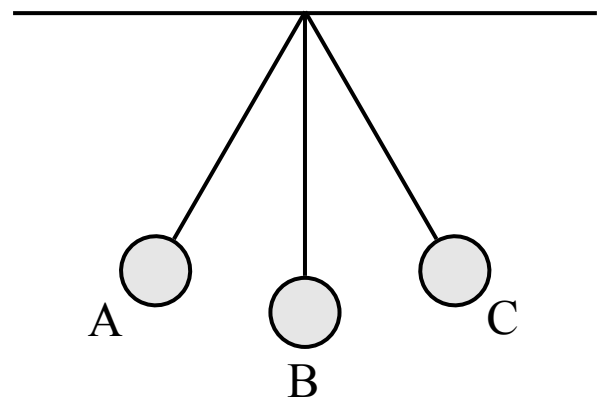
12. A tube is partially filled with a liquid with a density of ρ_0 as shown in the figure above. The ends of the tube are open. Which of the following is a correct expression for the absolute pressure at the point shown in the liquid?

(A) $\rho_0 g \Delta y$

(B) $P_{atm} - \rho_0 g \Delta y$

(C) $\rho_0 g \Delta y - P_{atm}$

(D) $\rho_0 g \Delta y + P_{atm}$



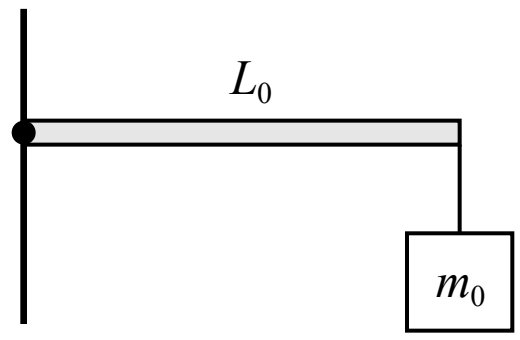
13. A pendulum consists of a sphere attached to a string suspended from the ceiling. As the sphere swings across from position A to position C, what is the direction of the acceleration of the sphere at position B?

(A) →

(B) ↑

(C) ←

(D) The acceleration is zero



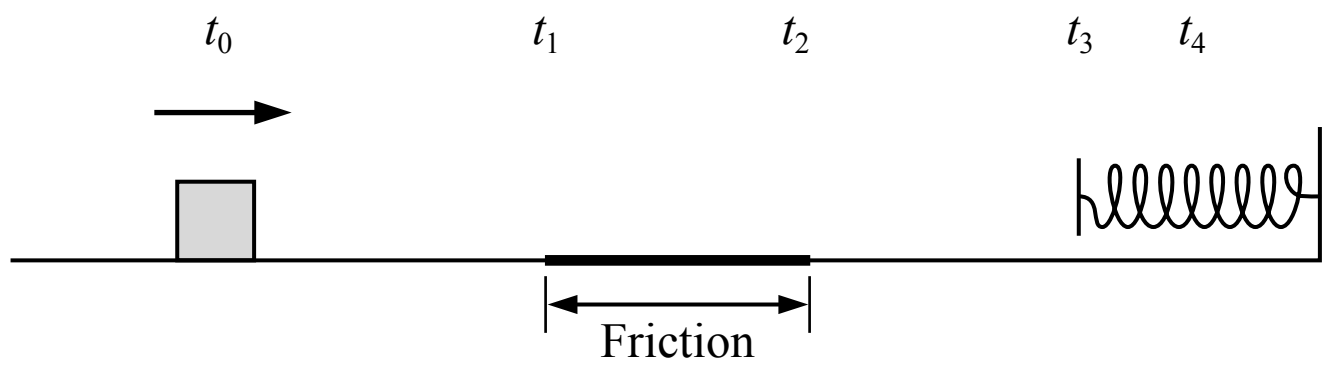
14. A beam with negligible mass and a length of L_0 is attached to a wall at its left end. A block with a mass of m_0 is suspended from the right end of the beam by a string with negligible mass, producing a torque of τ_0 about the left end of the beam. If the length of the beam was changed to $L_0/3$ and the mass was changed to $2m_0$, the torque produced about the left end of the beam would be

(A) $2\tau_0/3$

(B) $6\tau_0$

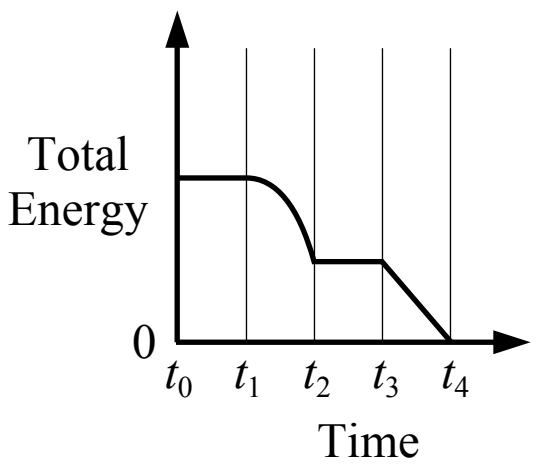
(C) $3\tau_0/2$

(D) $\tau_0/3$

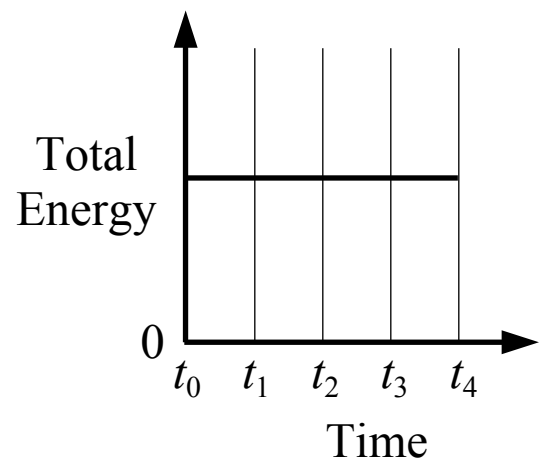


15. A block is sliding across a surface with negligible friction at a constant speed at time t_0. The block then slides over a patch where friction acts on the block from time t_1 to time t_2. The block then again slides across a surface with negligible friction from time t_2 to time t_3. The block comes into contact with a spring at time t_3 and compresses the spring until the block momentarily comes to rest at time t_4. Which of the following graphs show the total energy of the block-spring system over time?

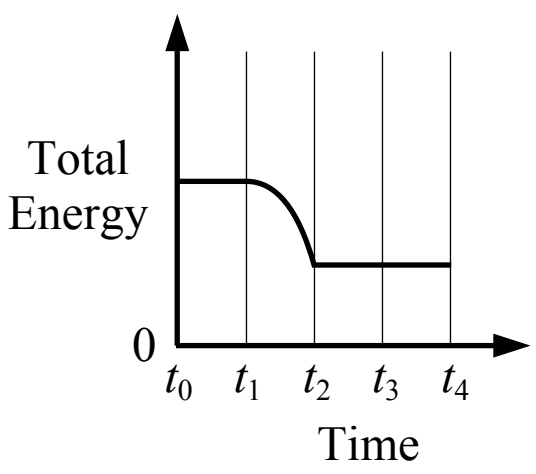
(A)



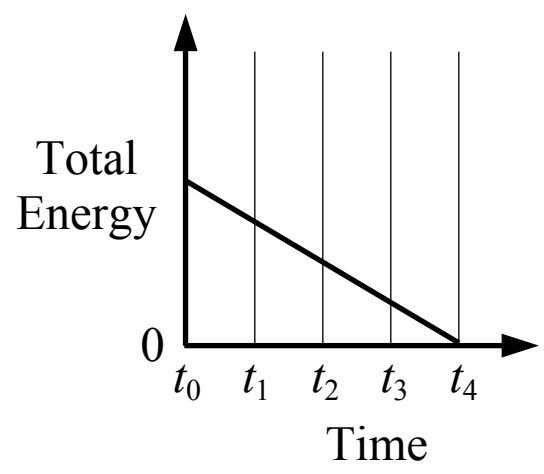
(B)

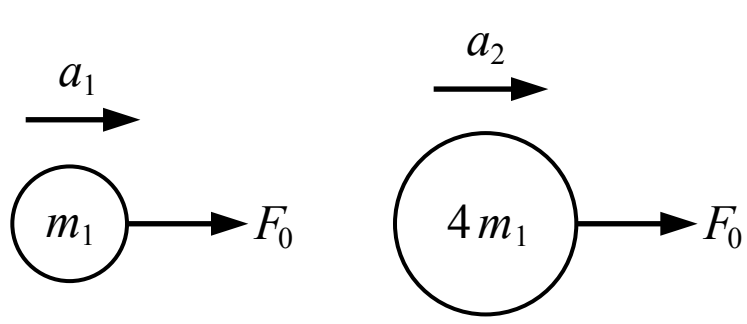


(C)



(D)





16. A force with a magnitude of F_0 acts on an object with a mass of m_1, causing it to move with an acceleration of a_1. The same force is applied to an object with a mass of $4\,m_1$, causing it to move with an acceleration of a_2. Which of the following is the correct expression for a_2 in terms of a_1?

(A) a_1

(B) $4\,a_1$

(C) $\dfrac{a_1}{16}$

(D) $\dfrac{a_1}{4}$

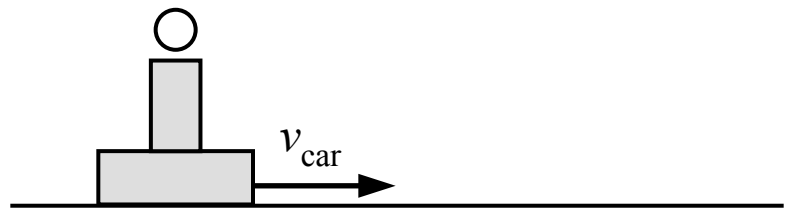
17. Two blocks are sliding towards each other on a surface with negligible friction as shown in the figure above. The blocks collide and stick together. Which direction do the blocks move after the collision?

(A) Right

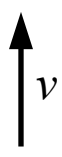
(B) Left

(C) They do not move after the collision

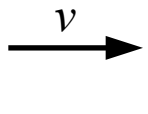
(D) Cannot be determined

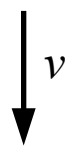


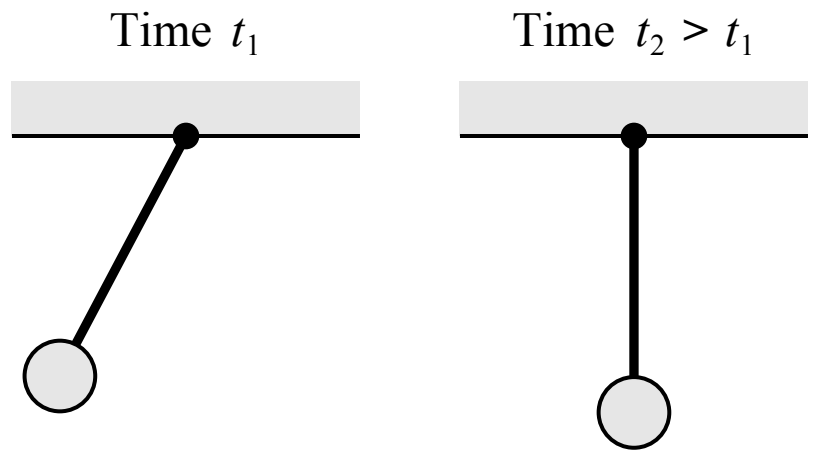
18. A ball is in a spring-loaded gun mounted on the top of a small car which is moving on a frictionless track as shown in the figure above. While the car is moving with a constant speed the ball is launched directly upwards relative to the car. The ball lands back in the gun 3 seconds later. The direction of the ball's velocity vector 2 seconds after being launched (relative to the ground) is most nearly

(A) 

(B) 

(C) 

(D) 



19. A pendulum consisting of a rod and a sphere is free to pivot about the point where the rod is attached to the ceiling as shown in the figure above. The pendulum is released from rest at the position shown at time t_1. The pendulum swings back and forth and is momentarily vertical at a later time t_2. Which of the following correctly describes how the angular speed of the pendulum is changing at time t_1 and time t_2?

(A)

Angular speed at t_1	Angular speed at t_2
Not changing	Not changing

(B)

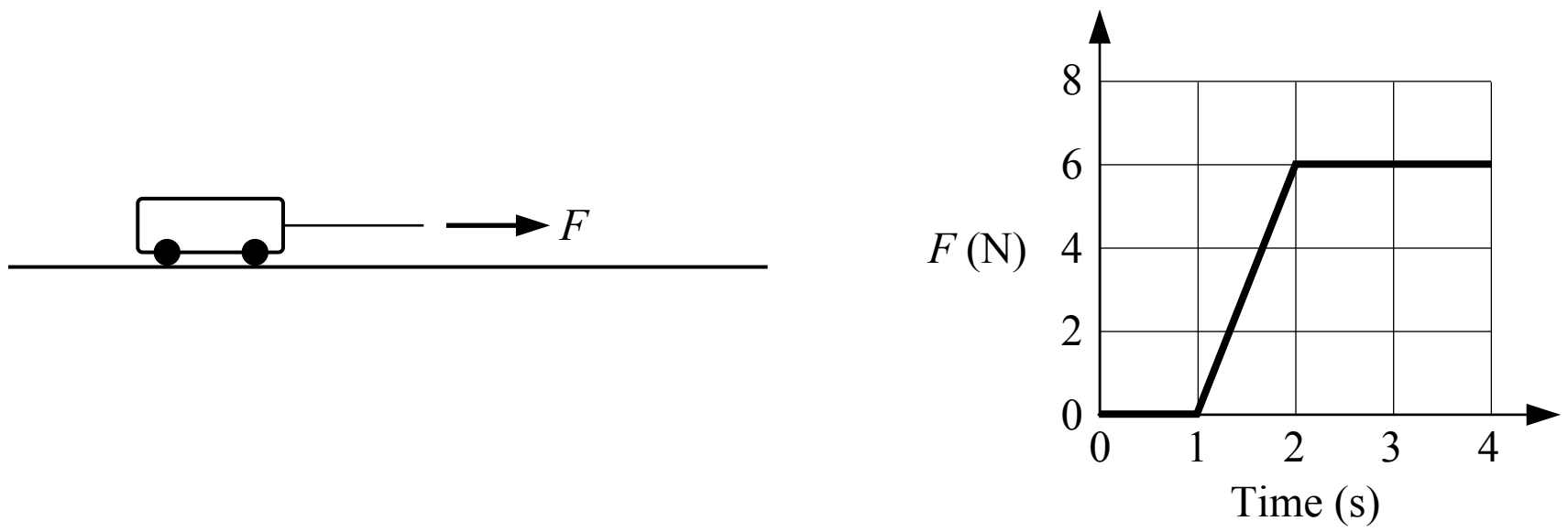
Angular speed at t_1	Angular speed at t_2
Increasing	Increasing

(C)

Angular speed at t_1	Angular speed at t_2
Decreasing	Increasing

(D)

Angular speed at t_1	Angular speed at t_2
Increasing	Not changing



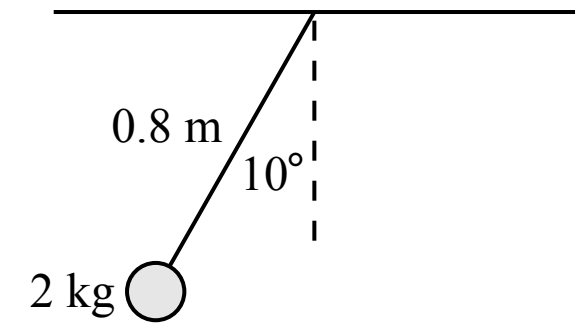
20. A cart is pulled along a horizontal track with negligible friction by a varying force F. A graph of the applied force over time is shown in the figure above. What is the change in momentum of the cart between 0 seconds and 3 seconds?

(A) 9 kg·m/s

(B) 12 kg·m/s

(C) 18 kg·m/s

(D) Cannot be determined



Note: Figure not drawn to scale.

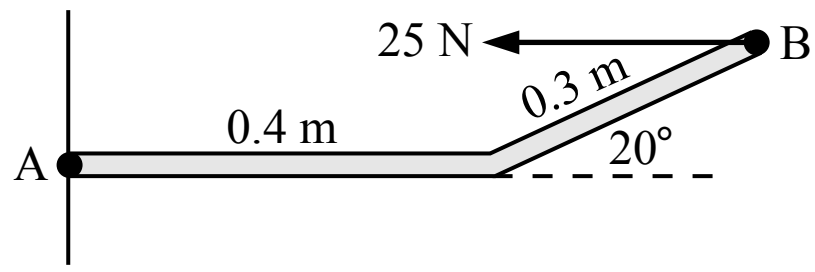
21. A 2 kg sphere is attached to a 0.8 m long cable with negligible mass to form a pendulum as shown in the figure above. The pendulum is released from rest at the position shown. The speed of the sphere at the lowest point in the motion is most nearly

(A) 4.0 m/s

(B) 0.5 m/s

(C) 3.6 m/s

(D) 1.7 m/s



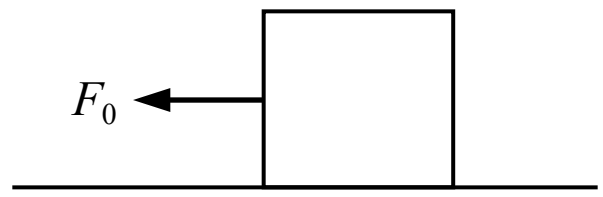
22. A rod consisting of a 0.4 m long segment and a 0.3 m long segment is attached to a wall at point A as shown in the figure above. A 25 N force acts horizontally at point B on the rod. The magnitude of the torque produced by the 25 N force about point A is

(A) 10 N·m

(B) 2.6 N·m

(C) 6.0 N·m

(D) 3.4 N·m



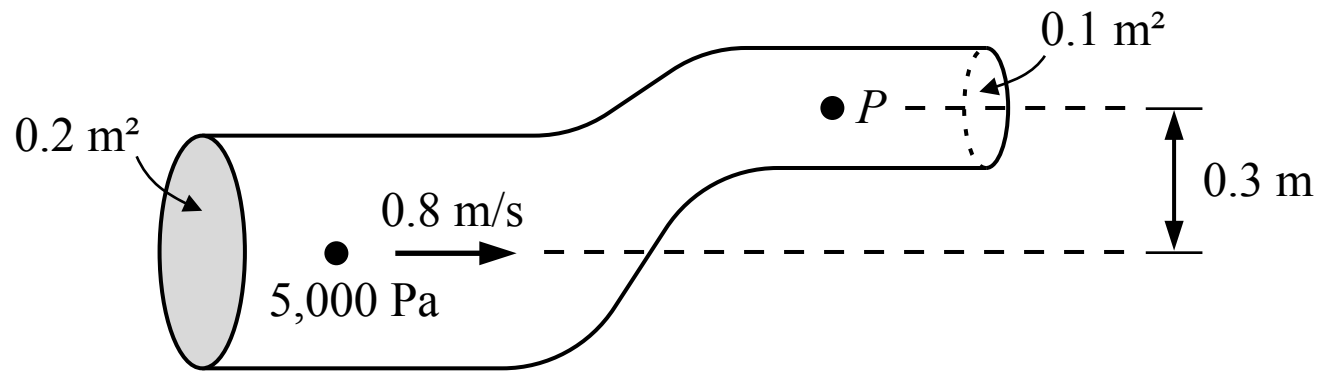
23. A block is sitting on a floor and the friction force between the block and the floor is not negligible. A force is applied to the block as shown in the figure above and the block remains at rest. Which of the following is true about the friction force acting on the block from the floor while the force is applied?

(A) The magnitude of the friction force is less than the magnitude of F_0

(B) The magnitude of the friction force is greater than the magnitude of F_0

(C) The magnitude of the friction force is equal to the magnitude of F_0

(D) The relationship between the magnitude of the friction force and the magnitude of F_0 cannot be determined



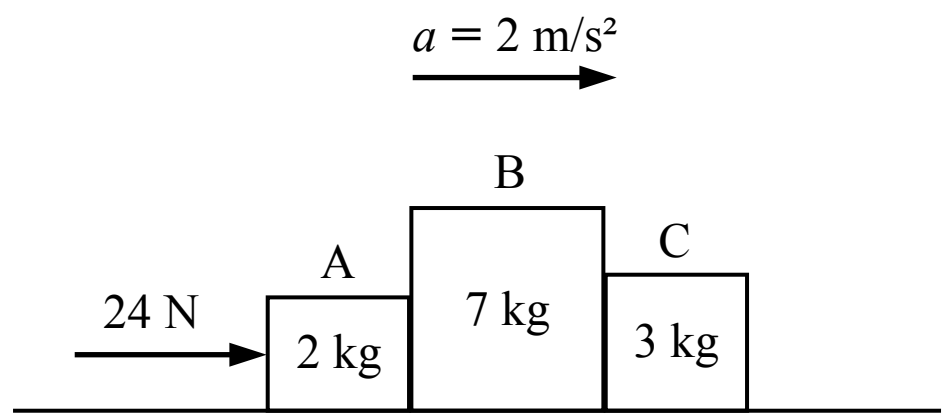
24. Water is flowing through the tube shown in the figure above. What is the pressure P at the point shown in the figure? The density of the water is 1,000 kg/m³.

(A) 1,040 Pa

(B) 2,320 Pa

(C) 2,000 Pa

(D) 3,000 Pa



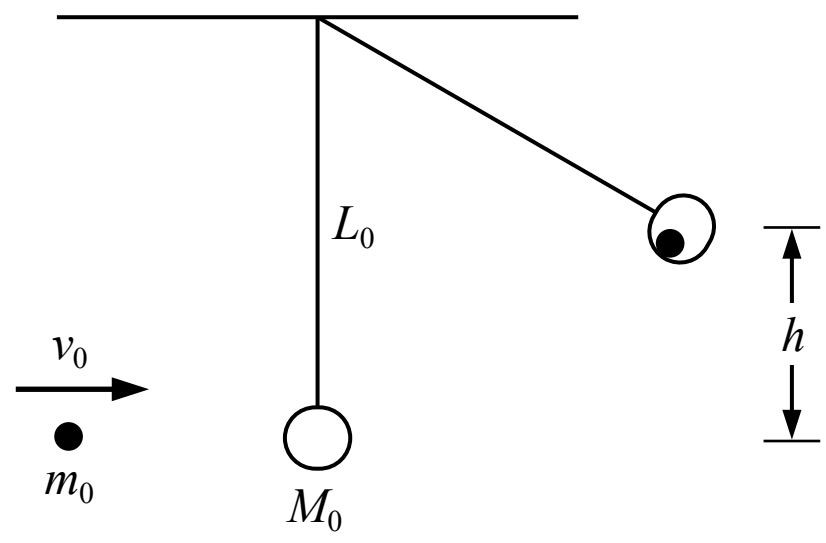
25. A force is applied to the left of three blocks with different masses which are sliding on a frictionless surface as shown in the figure above. The three blocks accelerate together without losing contact. What is the magnitude of the force that block C exerts on block B?

(A) 0 N

(B) 6 N

(C) 8 N

(D) 24 N



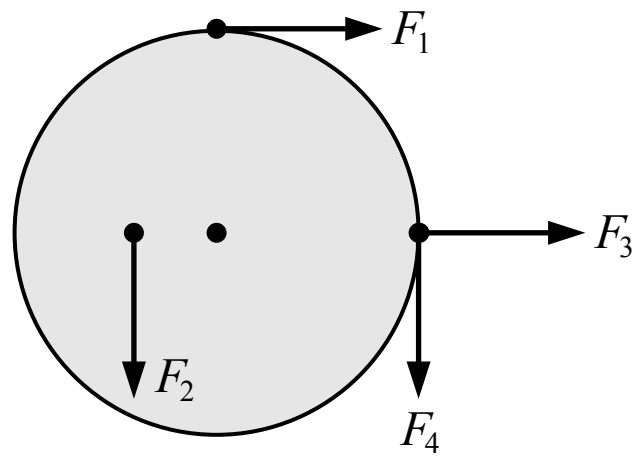
26. A small sphere of mass m_0 is shot at a ball of clay of mass M_0 which is suspended by a string with negligible mass. The ball of clay is initially at rest when the sphere impacts the ball of clay with a speed of v_0. The sphere sticks to the ball of clay and they swing upwards. What is the maximum height h that the sphere and ball of clay swing?

(A) $\dfrac{m_0 v_0}{m_0 + M_0}$

(B) $\dfrac{1}{2} m_0 v_0^2$

(C) $\dfrac{m_0 v_0^2}{2g(m_0 + M_0)}$

(D) $\dfrac{1}{2g}\left(\dfrac{m_0 v_0}{m_0 + M_0}\right)^2$



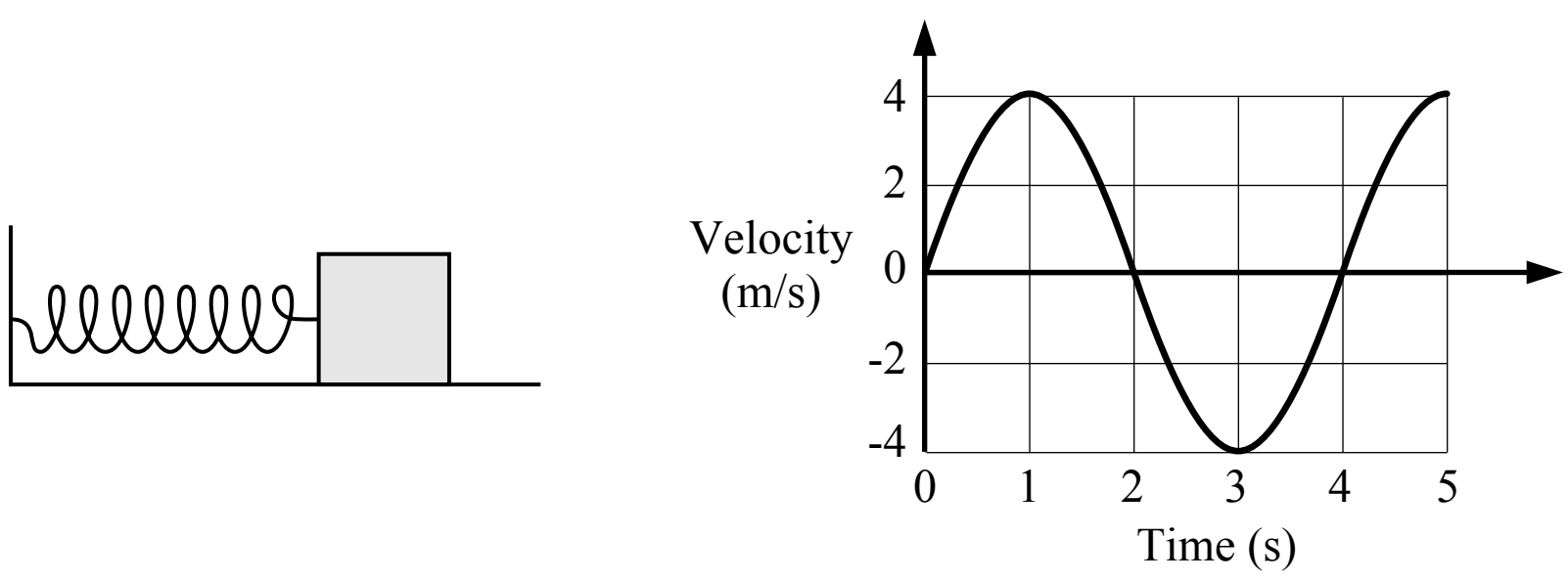
27. Four forces with equal magnitudes are exerted on a wheel as shown in the figure above. Which of the following correctly ranks the forces by the magnitude of the torque produced by each force about the center of the wheel?

(A) $F_2 < (F_1 = F_3 = F_4)$

(B) $F_3 < F_4 < F_1 < F_2$

(C) $F_3 < F_2 < (F_1 = F_4)$

(D) $F_2 < F_4 < (F_1 = F_3)$



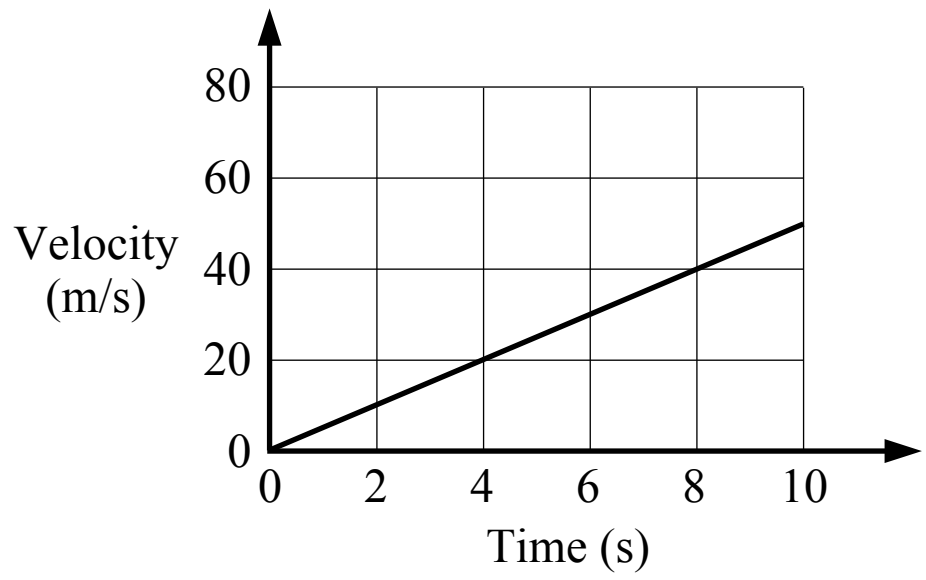
28. A mass is attached to a spring and moves back and forth on a surface with negligible friction. A graph of the motion of the block is shown in the graph above. At which of the following times is the magnitude of the spring force on the block the greatest?

(A) 1 s

(B) 3 s

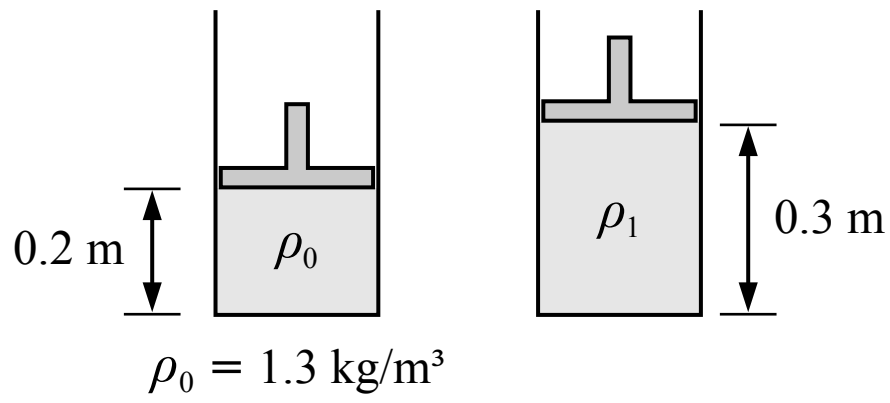
(C) 1.5 s

(D) 2 s



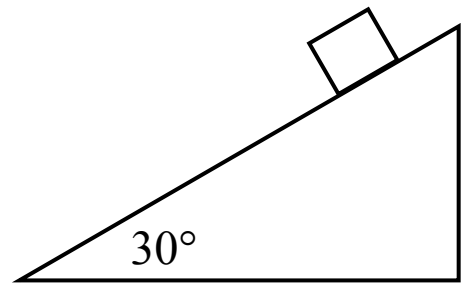
29. A racing team wants to determine the maximum acceleration of their car on a straight track. They record the motion of the car during a period of time, which is shown in the graph above, and they calculate the acceleration. The car then participates in a 250 m long race on a straight track. If the car starts from rest and accelerates at this rate the entire time, the time it takes the car to finish the race is most nearly

(A) 7 s
(B) 14 s
(C) 10 s
(D) 50 s



30. A volume of gas is contained in a cylinder below a piston as shown in the figure above. The density of the gas is 1.3 kg/m³. When the piston is raised to the new position shown in the figure, the density of the gas is most nearly

(A) 0.9 kg/m³
(B) 2.0 kg/m³
(C) 1.3 kg/m³
(D) Cannot be determined



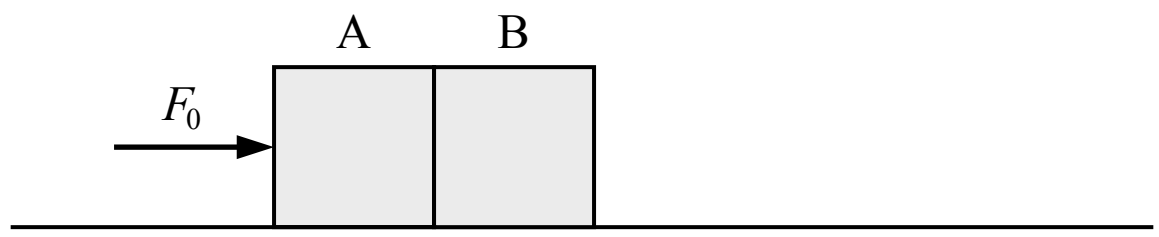
31. A block is held on an incline with negligible friction near the surface of planet X, where there is no air resistance and the gravitational acceleration is different from earth. The block is released from rest. After the block slides 2 m along the incline it is moving at a speed of 2.8 m/s. The gravitional acceleration near the surface of planet X is most nearly what percent of the gravitational acceleration near the surface of earth?

(A) 10%

(B) 20%

(C) 23%

(D) 40%



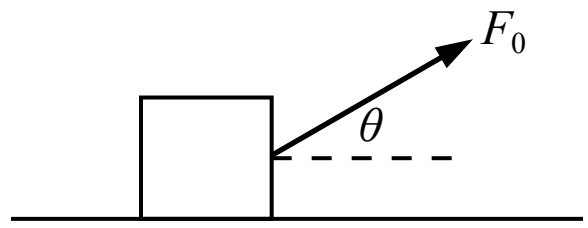
32. Two blocks A and B are on a frictionless surface. At an initial time t_1 a force F_0 acts on block A as shown in the figure above. At a later time of t_2 the force F_0 has been removed. How does F_{BA} , the force of block B on block A, compare between the two times?

(A) F_{BA} at time $t_1 = F_{BA}$ at time t_2

(B) F_{BA} at time $t_1 > F_{BA}$ at time t_2

(C) F_{BA} at time $t_1 < F_{BA}$ at time t_2

(D) Cannot be determined



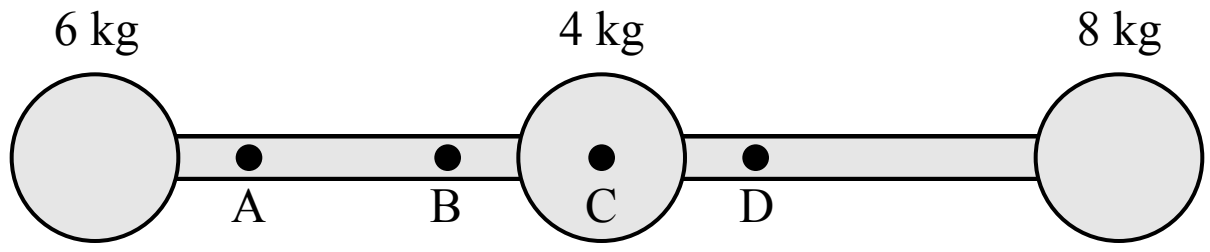
33. A block is sitting on the floor and the friction between the block and the floor is not negligible. A force is then applied to the box at an angle θ above the horizontal as shown in the figure above and the box slides across the floor. If the angle θ is increased but the magnitude of the force remains the same and block continues sliding then

(A) the magnitude of the friction force on the block will increase

(B) the magnitude of the friction force on the block will decrease, but not to zero

(C) the magnitude of the friction force on the block will not change

(D) the magnitude of the friction force on the block will be zero



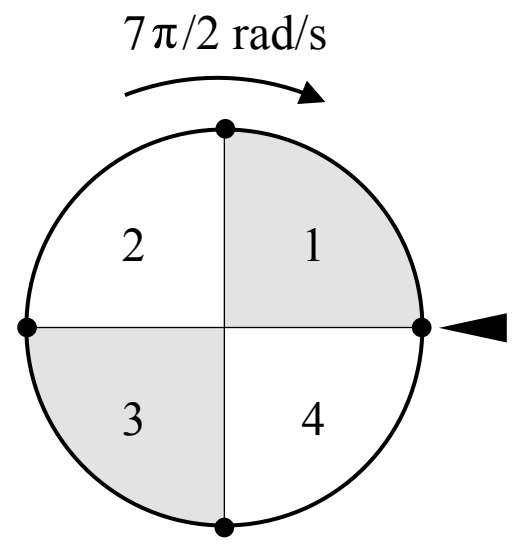
34. A system consists of a three spheres connected by two rods with equal length and uniform mass as shown in the figure above. The center of mass of the system is closest to which of the points shown?

(A) Point A

(B) Point B

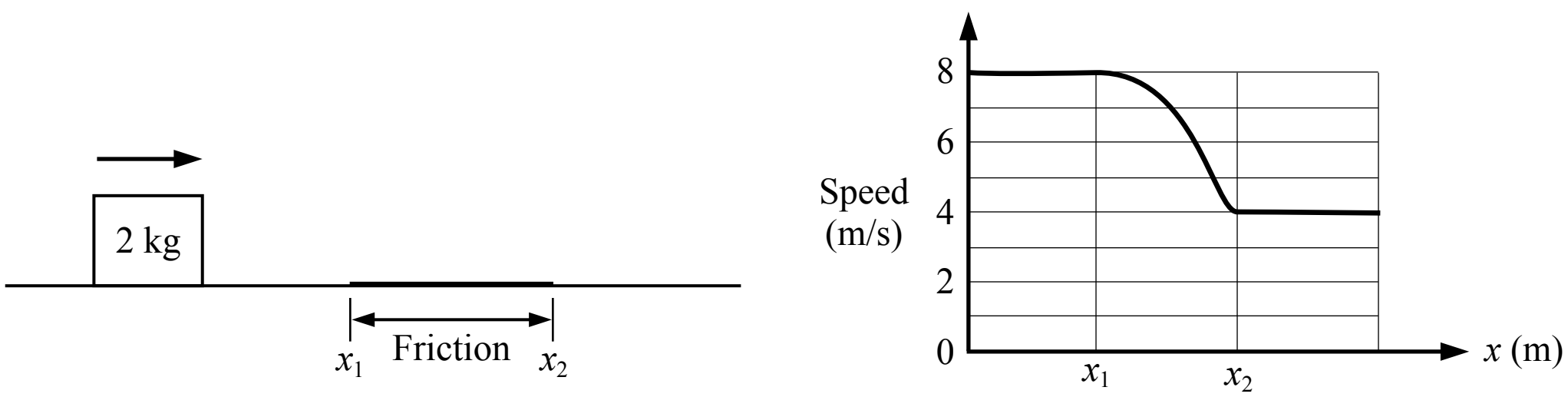
(C) Point C

(D) Point D



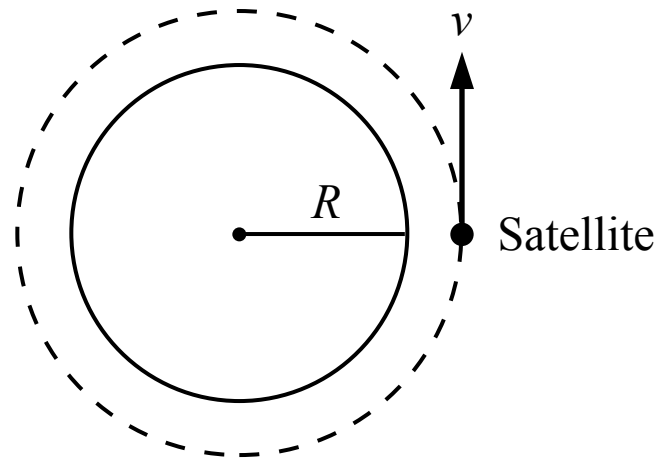
35. A wheel is divided into 4 equal sections as shown in the figure above. The wheel is given a spin and released so that the initial angular speed of the wheel is $7\pi/2$ rad/s when the wheel is in the orientation shown above. The wheel slows down at a rate of $-\pi/2$ rad/s². What numbered section is the arrow on the right pointing to when the wheel stops?

(A) 1
(B) 2
(C) 3
(D) 4



36. A block is sliding across a surface with negligible friction except for the length of surface between x_1 and x_2. A graph of the block's motion is shown in the figure above. The work done on the block by friction is most nearly

(A) -48 J
(B) -16 J
(C) -64 J
(D) Cannot be determined



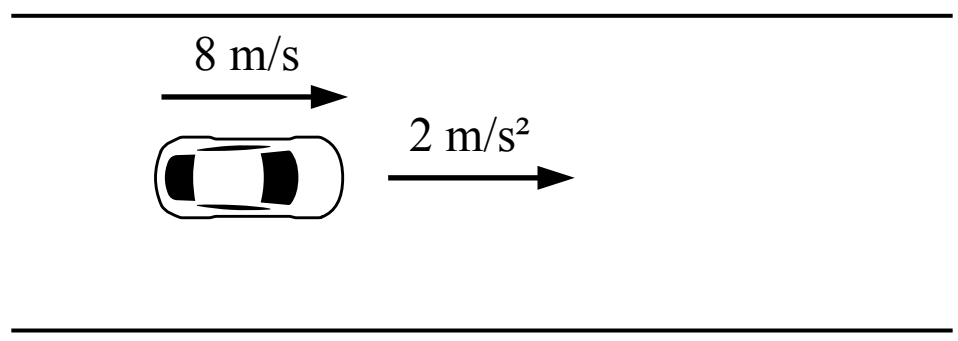
37. A satellite is in a circular orbit around the Earth at height of 2,000 km above the surface of the earth. The radius of the earth is 6,371 km. If the satellite completes one orbit every 2 hours, the speed of the satellite is most nearly

(A) 1.7 km/s

(B) 5.6 km/s

(C) 6.4 km/s

(D) 7.3 km/s



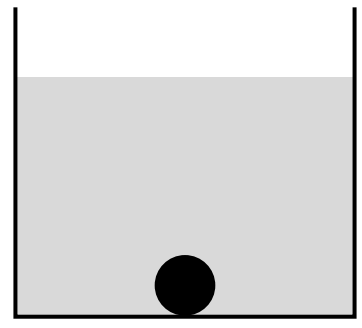
38. A 1500 kg car is driving at a speed of 8 m/s. It then accelerates at 2 m/s² for a period of 3 seconds. The kinetic energy of the car after that period is most nearly

(A) 147 kJ

(B) 48 kJ

(C) 27 kJ

(D) 14 kJ



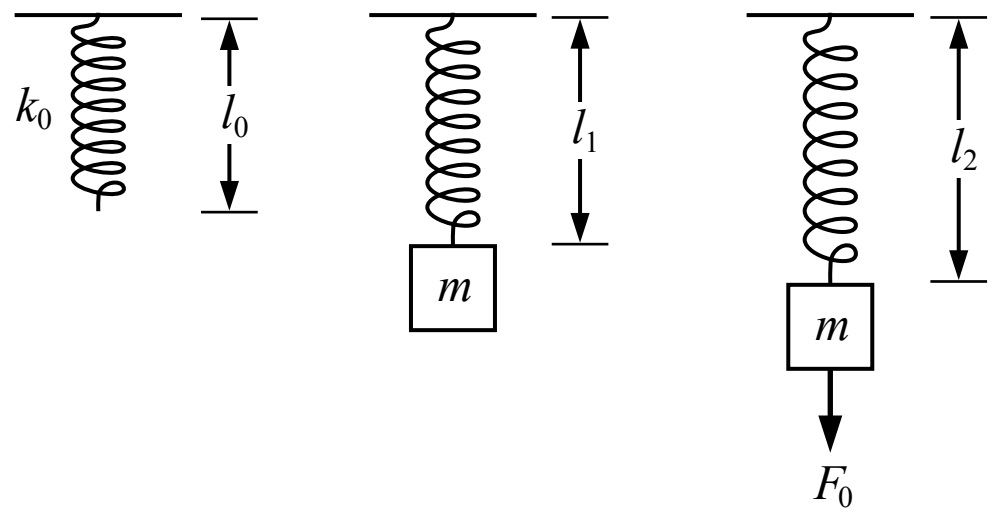
39. A ball is dropped into a container of liquid and it sinks to the bottom as shown in the figure above. Which of the following statements is true about the forces acting on the ball?

(A) The magnitude of the buoyant force acting on the ball is less than the weight of the ball but not zero

(B) The magnitude of the buoyant force acting on the ball is equal to the weight of the ball

(C) The magnitude of the buoyant force acting on the ball is greater than the weight of the ball

(D) The magnitude of the buoyant force acting on the ball is zero



40. A spring with a spring constant of k_0 and an unstretched length of l_0 is suspended from the ceiling as shown in the figure above. A block with a mass of m is then attached to the bottom end of the spring and the block is at rest when the spring has a length of l_1. A force with a magnitude of F_0 then pulls down on the block so that the spring has a length of l_2 and the block is at rest. The moment that the force F_0 is removed, the acceleration of the block is

(A) $k_0(l_2 - l_1)$

(B) $\dfrac{k_0(l_2 - l_1)}{m} - g$

(C) $\dfrac{k_0(l_2 - l_0)}{m} - g$

(D) $k_0(l_2 - l_0)$