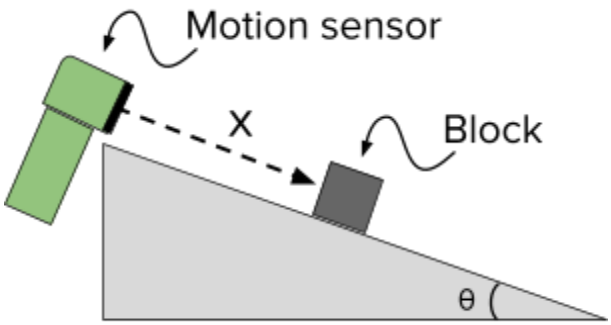
**Practice AP Physics 1 Diagnostic MC exam (32 questions, 58 minutes)** *You may assume g=10m/s²*
*Do all the questions* and *then* check your answers which are shown on the final page of this document.

1. A block is released from rest on a frictionless ramp in the position shown in the diagram and the block's position is measured by a motion sensor. Which of the following equations would be the most likely result given by the motion sensor for the position x of the block as a function of time?



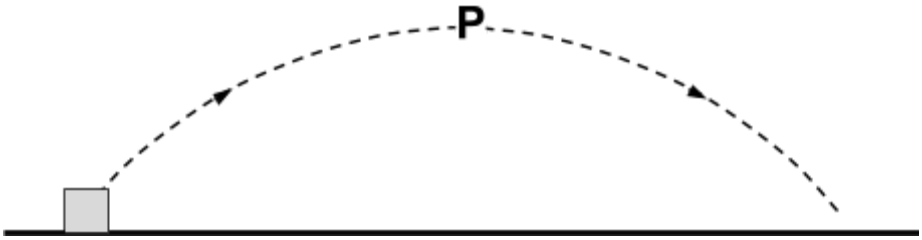

(A) $x(t) = 0.3 + 2t + 4t^2$

(B) $x(t) = 0.3 + 2t - 4t^2$

(C) $x(t) = 0.3 - 4t$

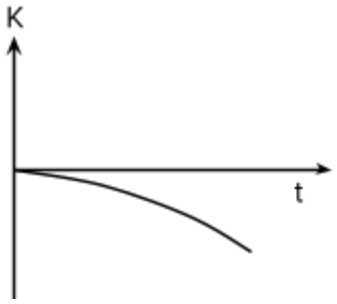
(D) $x(t) = 0.3 + 4t^2$

2.

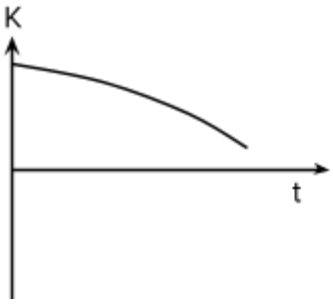



A cube is launched at an angle and flies through the air with negligible air resistance as seen in the diagram above. Which of the following graphs best represents the kinetic energy K of the cube as a function of time starting at t=0 when the cube is at point P and ending some time before it hits the ground?

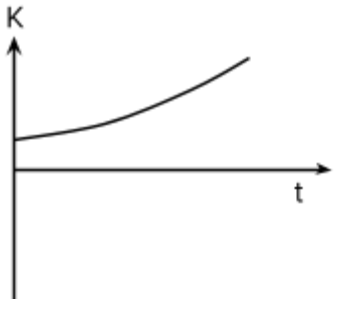
(A)



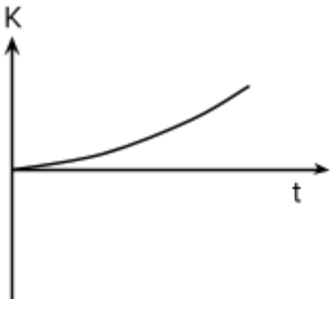

(B)




(C)




(D)

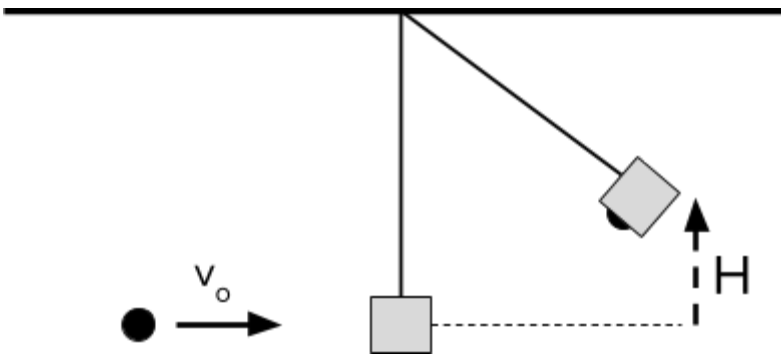


3. A planet has half the radius of Earth and one sixth the mass of the earth. What would be the best estimate for the magnitude of the gravitational field at the surface of the planet?

(A) 1.67 N/kg
(B) 3.33 N/kg
(C) 6.67 N/kg
(D) 8.33 N/kg

4.

A sphere of mass M is moving with a speed $v_o$ embeds itself in a cube of identical mass M that is at rest and hanging from a light string. After the collision, the center of mass of the sphere-cube system swings to a maximum height H relative to the original height of the cube. What is the best expression for the maximum height H in terms of $v_o$ and g?




(A) $\frac{v_o^2}{g}$

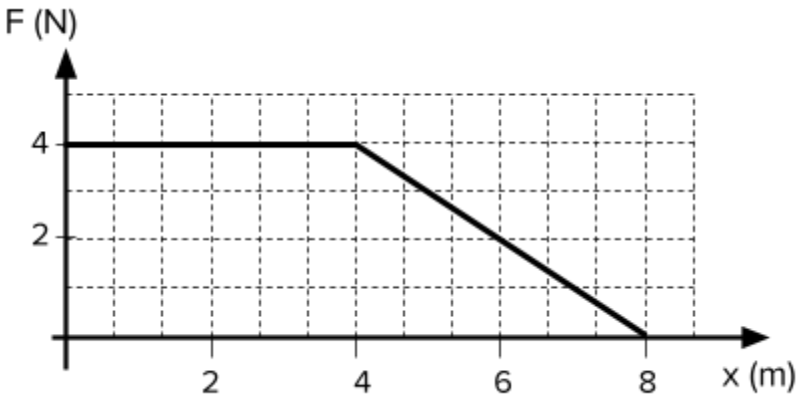
(B) $\frac{v_o^2}{2g}$

(C) $\frac{v_o^2}{4g}$

(D) $\frac{v_o^2}{8g}$

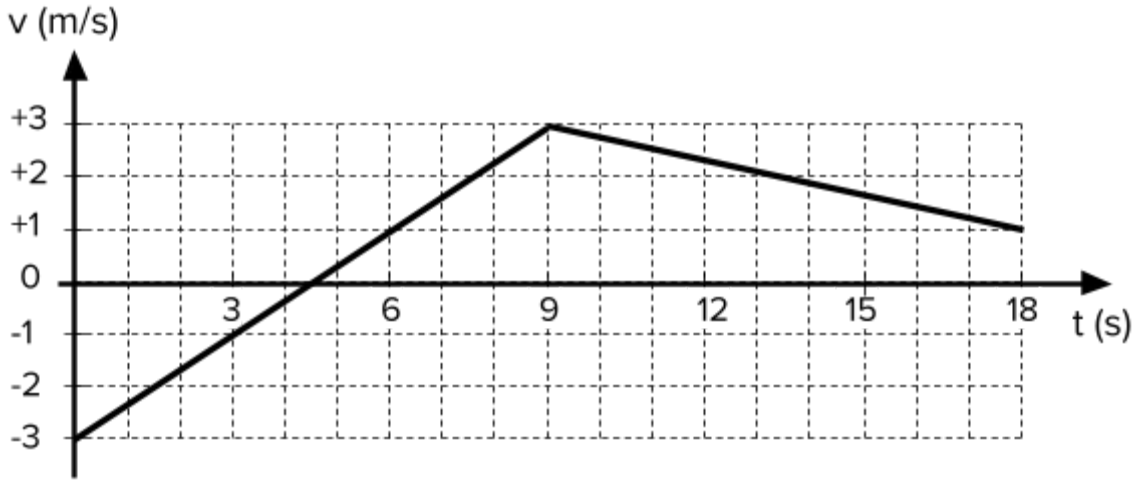
5.

A net force F is applied to a 3 kg cart that starts at rest at position x=0. The net force F as a function of the location x of the cart is shown in the graph to the right. What will the speed of the cart after it has moved 8m?




(A) 4 m/s
(B) 8 m/s
(C) 16 m/s
(D) 24 m/s

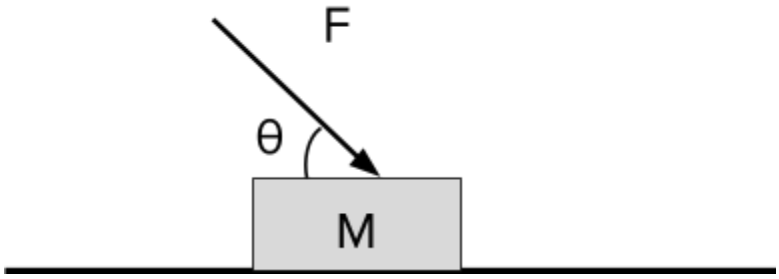
6.




The graph above gives the horizontal velocity of a remote control car that is moving along a straight line on a horizontal surface. Assume rightward is the positive direction. Which one of the following statements about the car is correct?

(A) The car changes directions at 9s
(B) The car is slowing down at 2s
(C) The car is moving with faster at 6s than it is at 15s
(D) The magnitude of the net force on the car is greater at 12s than it is at 6s

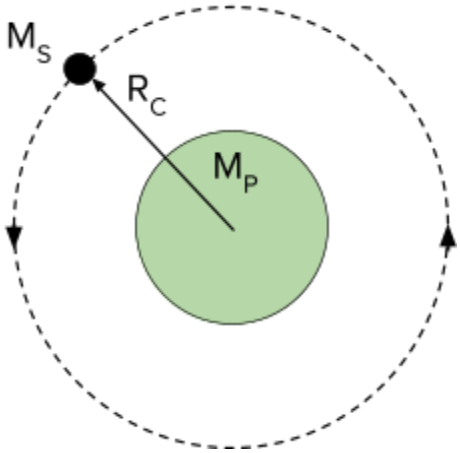
7.




A block of mass M is being pushed along a rough horizontal floor at constant speed with a force of magnitude F directed at an angle θ as seen in the diagram above. What is the normal force exerted on the block by the floor and the force of friction exerted on the block by the floor?

| | **Normal force** | **Frictional force** |
|---|---|---|
| (A) | Mg - Fsinθ | Mgcosθ |
| (B) | Mg + Fcosθ | Fsinθ |
| (C) | Mg + Fsinθ | Fcosθ |
| (D) | Mg - Fcosθ | Mgsinθ |

8. A satellite of mass $M_S$ orbits in a circle of radius $R_C$ at a constant speed $v_o$ around a planet of mass $M_P$ and radius $R_P$ as seen in the diagram to the right. If the mass of the satellite and mass of the planet were doubled to $2M_S$ and $2M_P$ respectively, what would be the speed of the satellite of mass $2M_S$ orbiting in a circle with the same radius $R_C$ at constant speed?




(A) $\sqrt{2}v_o$

(B) $2v_o$

(C) $\frac{v_o}{\sqrt{2}}$

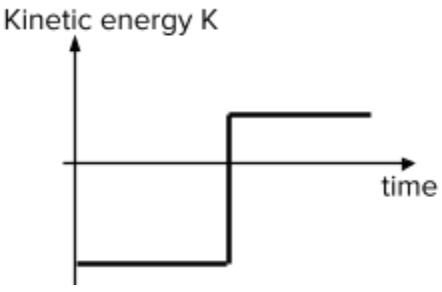
(D) $4v_o$

9.

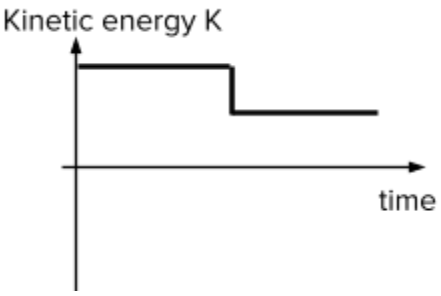



Two carts of mass m and M head toward each other on a frictionless track with the same speed and stick together as seen in the diagram above. Assume M > m. Which of the following is a realistic graph of the total kinetic energy of the two cart system as a function of time from a time before the collision until some time after the collision?

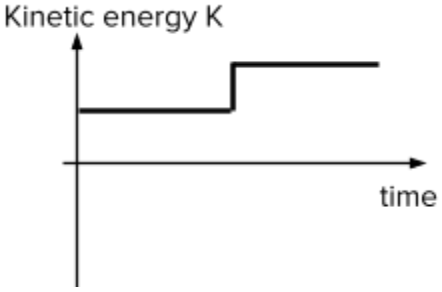
(A)



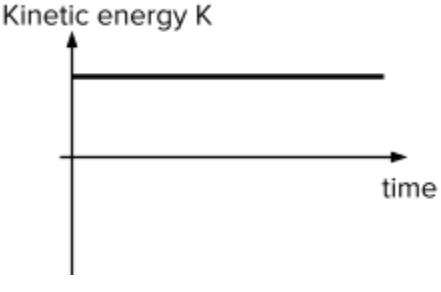

(B)




(C)

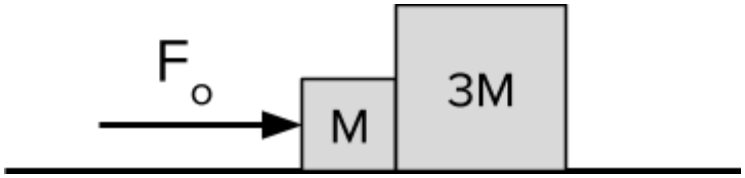



(D)



10.

A block of mass M and 3M sit next to each other on a frictionless floor. A force $F_o$ is exerted on mass M causing the system of masses to accelerate to the right. Let $F_{3M}$ be the magnitude of the force exerted on the 3M mass by the mass M, and $F_M$ be the magnitude of the force exerted on the mass M by the mass 3M. How do the three forces $F_o$, $F_{3M}$, and $F_M$ compare?




(A) $F_o > F_{3M} = F_M$

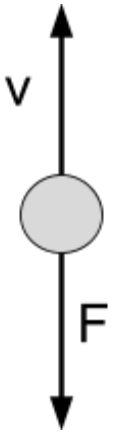
(B) $F_o = F_{3M} = F_M$

(C) $F_M > F_o > F_{3M}$

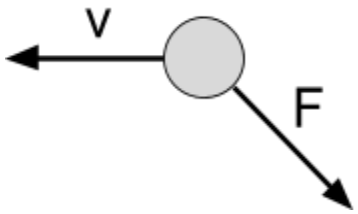
(D) $F_M = F_{3M} > F_o$

11. A ball has a velocity v and a net external force F exerted on it. In which of the following instants shown below, would the force F be doing negative work on the ball as well as changing the direction of the path of the ball?

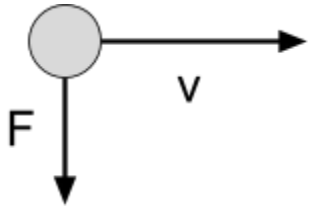
(A)



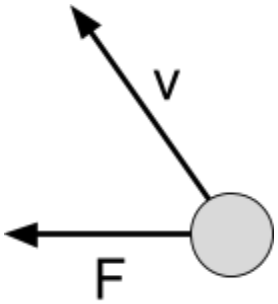

(B)




(C)

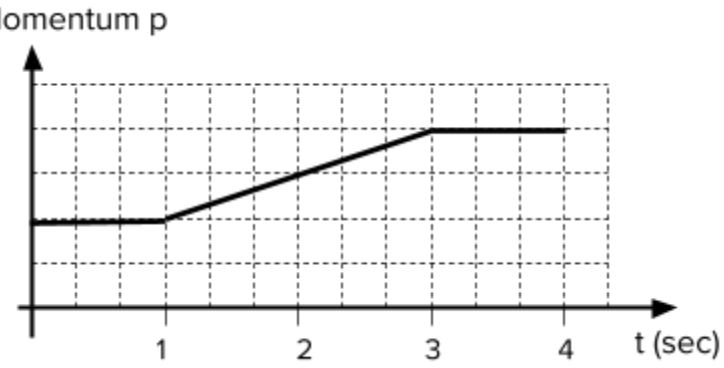



(D)

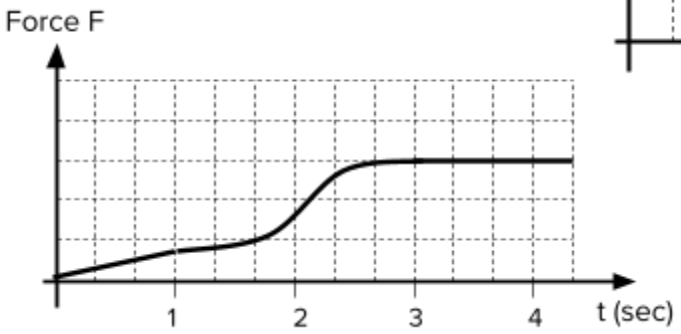


12.

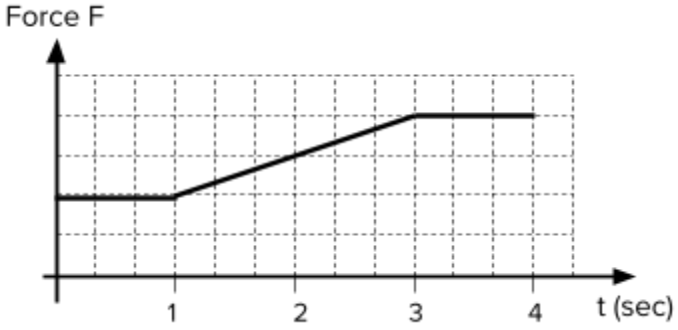
The momentum of a cart rolling along a straight track is shown in the graph to the right. Which of the following graphs could represent the net Force F acting on the cart as a function of time?



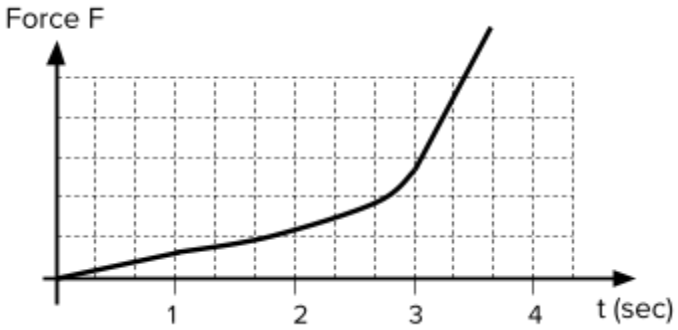

(A)



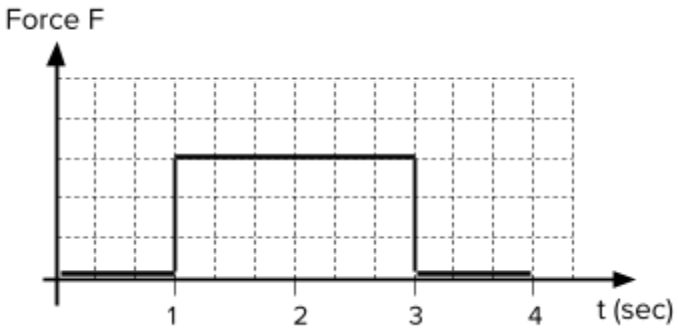

(B)



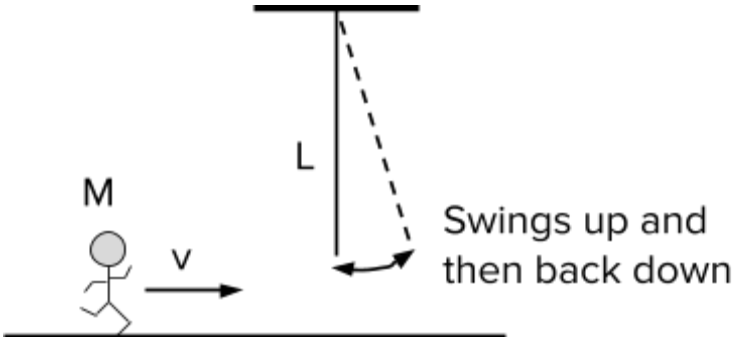

(C)




(D)



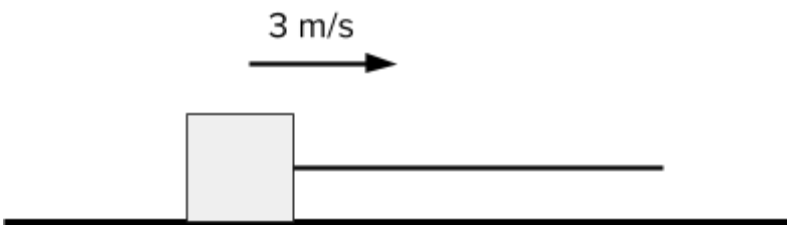
13.




A person running with a speed $v_o$ grabs onto a massless rope of length L, which causes them to swing up to a height H and then back down to the ground as seen above. What change to the scenario would cause the greatest increase in height attained by the person?

(A) Try it with a person of twice the mass (2M) running with three times the speed ($3v_o$)
(B) Try it with a person of three times the mass (3M) running with twice the speed ($2v_o$)
(C) Raise the ceiling and use a rope of twice the length, 2L
(D) None of these changes will affect the height attained by the person

14.

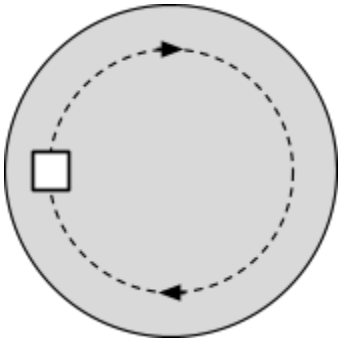



It takes 50N of tension in a string to drag a block across a rough surface at a constant speed of 3m/s as seen above. How much tension will be required in the string to drag the same block across the same rough surface at a constant speed of 6m/s?

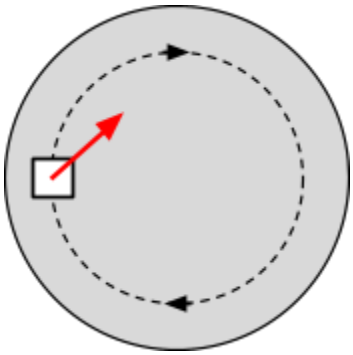
(A) 50N
(B) 75N
(C) 100N
(D) 200N

15.

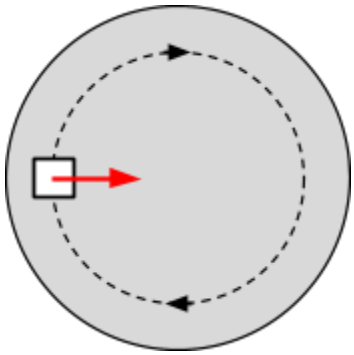
A white block sits on top of a turntable which is rotating clockwise as seen to the right. The white block does not slip on the turntable as it spins. If the turntable is speeding up while the block is at the position shown, which of the following would best represent the direction of the frictional force exerted on the block from the turntable?



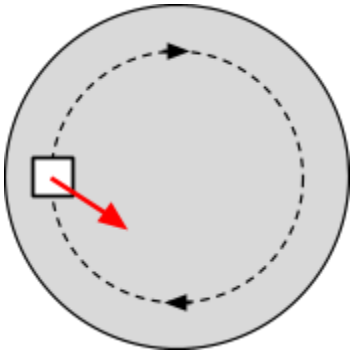
(A)



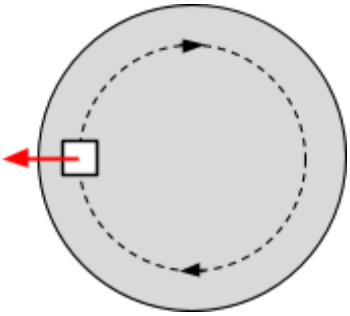
(B)



(C)



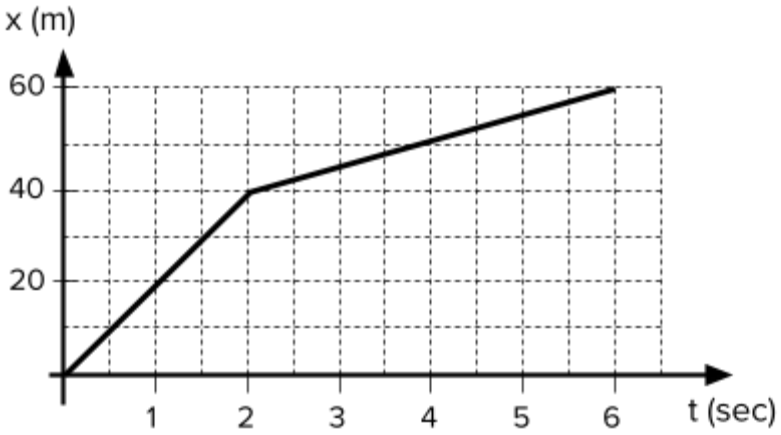
(D)



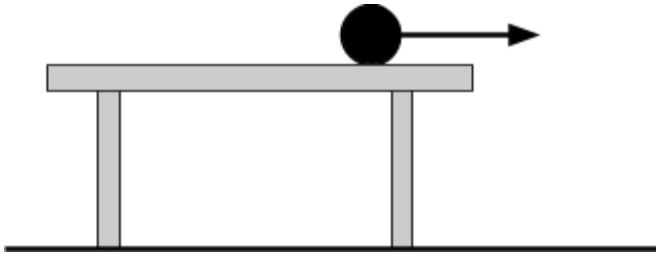
16.

A 4kg rocket sled is moving to the right along a straight horizontal track. The graph below gives the horizontal position x of the sled as a function of time. What was the net work done on the sled between 1 s and 3 s?

(A) -24 J
(B) -750 J
(C) +24 J
(D) +750 J

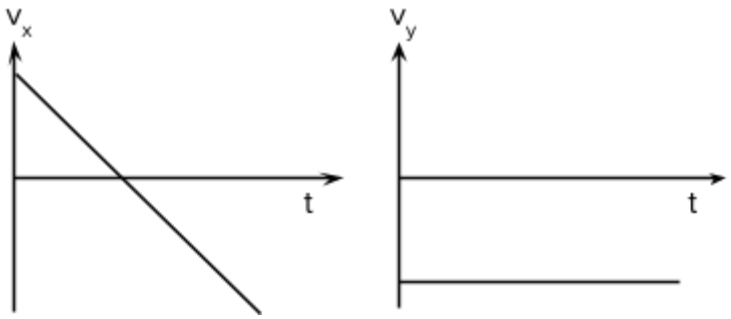


17.

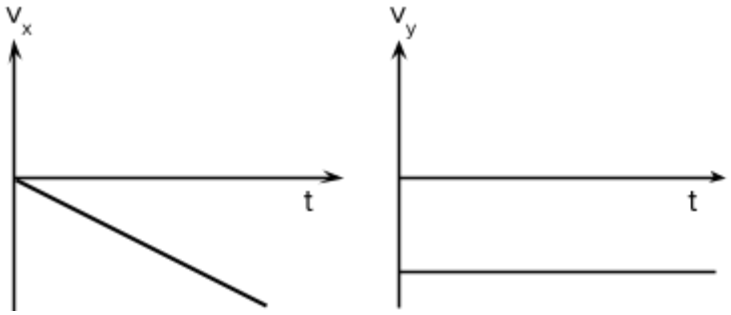


A ball rolls off a horizontal table and falls to the ground as seen above. What would be the best graph of the horizontal and vertical components of the velocity ($v_x$ and $v_y$) of the ball from the time it leaves the table until right before it hits the ground? Assume upward and rightward are the positive directions.

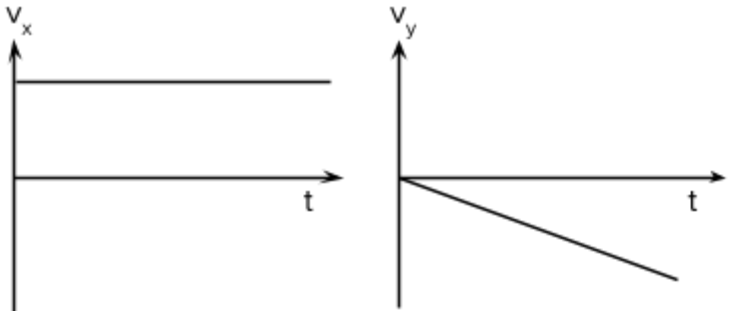
(A)



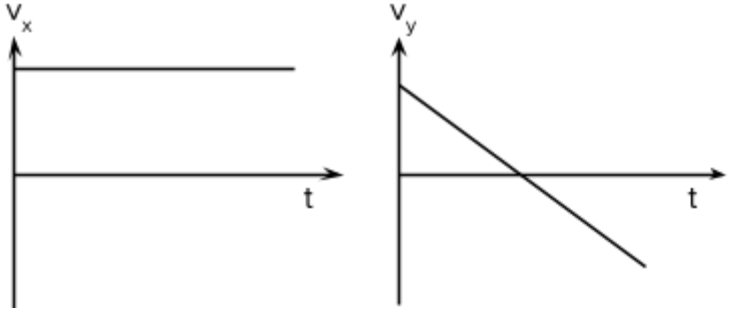

(B)




(C)




(D)



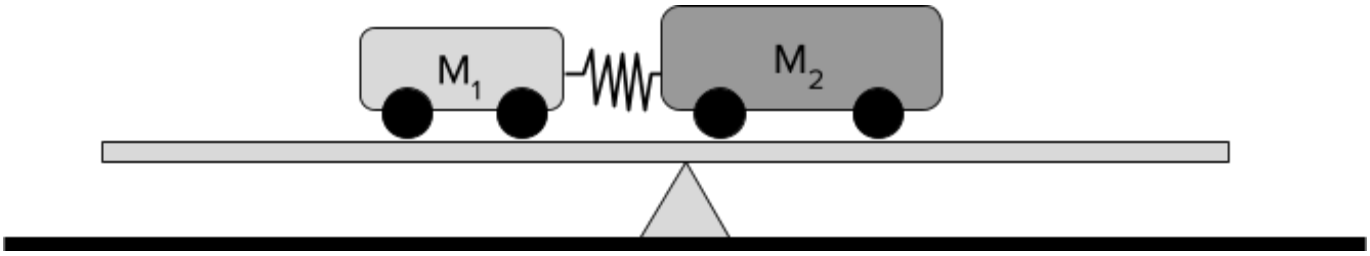
18.




A block of mass M approaches a frictionless incline of angle 2θ with a speed $v_o$. A block of mass 2M approaches a frictionless incline of angle θ with the same speed $v_o$. They both reach a maximum height from the ground on their respective ramps and slide back down. How do the maximum heights attained by the blocks compare?

(A) The maximum heights from the ground will be the same
(B) The M block will attain a larger maximum height from the ground
(C) The 2M block will attain a larger maximum height from the ground
(D) It is impossible to say without knowing the exact speed $v_o$

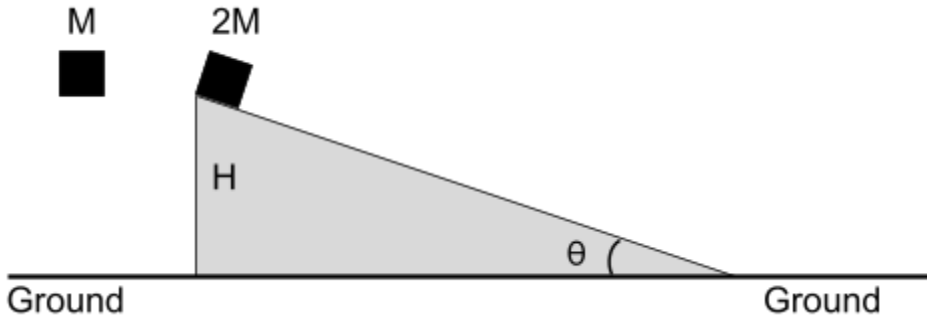
19.




The center of the board is above a pivot as seen in the diagram above. Two carts are connected with a compressed massless spring and sit at rest and balanced on the board. The mass of cart 2 ($M_2$) is larger than the mass of cart 1 ($M_1$). The spring will be released via remote control causing the carts to roll away from each other. As the carts start to roll away from each other, but before they reach the end of the board, what will happen to the board?

(A) The right end of the board will be dropping down
(B) The left end of the board will be dropping down
(C) The left end of the board will be oscillating up and down with simple harmonic motion
(D) Neither end of the board will be dropping down

20.




A block of mass 2M will be released from rest on a frictionless ramp at the same time that a block of mass M will be released from rest at the same height H and allowed to fall freely through the air. How do the magnitudes of the accelerations of the blocks compare, and how do the speeds of the blocks when they reach the ground compare?

| | **Magnitude of acceleration** | **Speeds when block reaches the ground** |
|---|---|---|
| (A) | $a_{2M} > a_M$ | $v_{2M} > v_M$ |
| (B) | $a_{2M} = a_M$ | $v_{2M} = v_M$ |
| (C) | $a_{2M} > a_M$ | $v_{2M} < v_M$ |
| (D) | $a_{2M} < a_M$ | $v_{2M} = v_M$ |

21.




Two blocks of mass 3M and M are released from rest at the top of two identical frictionless ramps. The blocks collide and stick together on the frictionless horizontal surface. Consider the time interval from right after the blocks are released until right after the collision. During this time interval, what happens to the mechanical energy of the system consisting of the two blocks and the Earth, and what happens to the mechanical energy of the system consisting of just the two blocks?

| | **Mechanical energy of the blocks-Earth system** | **Mechanical energy of blocks** |
|---|---|---|
| (A) | Increases | Increases |
| (B) | Decreases | Decreases |
| (C) | Remains the same | Decreases |
| (D) | Decreases | Increases |

22.




Block A, of mass M, is moving with a speed $v_A$ to the right along a frictionless surface when it has a perfectly elastic collision with Block B (also of mass M) which makes block B slide up to a height H on the frictionless ramp. With what speed should the block A be sent in with, in order to get block B to slide to a height 2H, assuming another perfectly elastic collision?

(A) $\sqrt{2}v_A$

(B) $2v_A$

(C) $4v_A$

(D) $8v_A$

23.

A ball of mass M, radius R, and rotational inertia $I$ is released from rest on an inclined ramp of height H and rolls without slipping to the bottom of the ramp. What will be the angular speed of the ball about its center of mass when it reaches the bottom of the ramp?

(A) $\sqrt{\frac{2MgH}{I+MR^2}}$

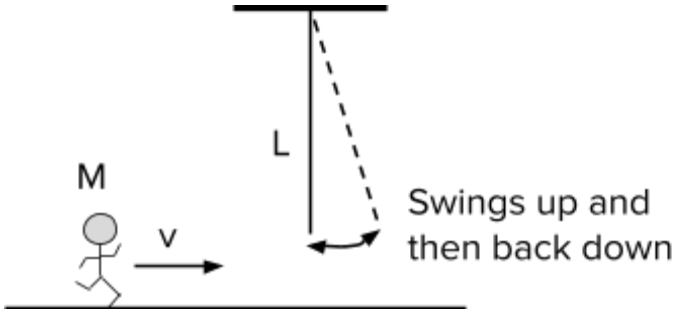
(B) $\sqrt{\frac{MgH}{I+MR^2}}$

(C) $\sqrt{\frac{2gH}{R^2}}$

(D) $\sqrt{\frac{gH}{R^2}}$

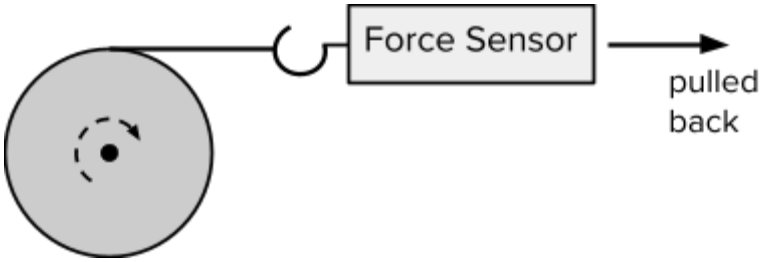
24.

A person running with a speed $v_o$ grabs onto a massless rope of length L, which causes them to swing up to a small angle and then back down to the ground as seen to the right. What change to the scenario would cause the greatest increase in time required to swing up and then back down?




(A) Try it with a person of twice the mass, 2M
(B) Have the person run twice as fast, $2v_o$
(C) Raise the ceiling and use a rope of twice the length, 2L
(D) None of these changes will affect the time required to swing up and back down

25.

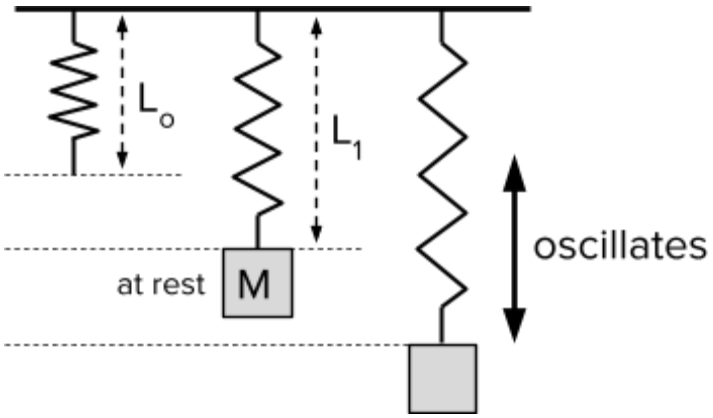



A student pulls with constant force on a rope wrapped around a massive cylinder that can rotate around a frictionless axle at its center. When the student pulls the rope for a time T the initially stationary cylinder is observed to spin through 10 full revolutions. If the student were to pull with the same force F, again with an initially stationary cylinder, but for twice the time (i.e. 2T), how many revolutions would the cylinder spin through? *Assume the rope does not slip against the cylinder.*

(A) 20 revolutions
(B) 30 revolutions
(C) 40 revolutions
(D) 80 revolutions

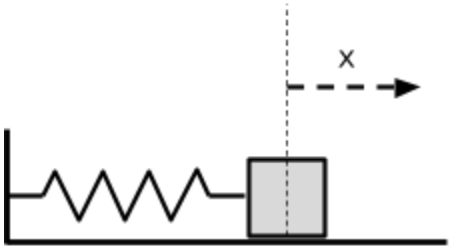
26.

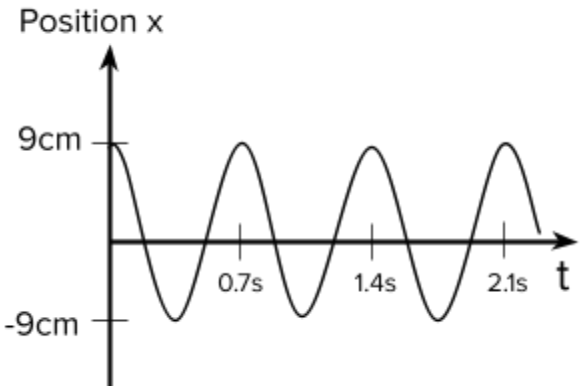
A massless spring of known spring constant has an unstretched length of $L_o$ when it hangs from the ceiling in a classroom. A cube of unknown mass is hung from the spring at rest and the new length $L_1$ of the spring is measured. Then the mass is pulled down an extra amount, released, and the time of oscillation is recorded. Which quantities can be determined from this experiment?




(A) Only inertial mass of the cube
(B) Only gravitational mass of the cube
(C) Both the inertial mass of the cube and the gravitational mass of the cube
(D) Neither the inertial mass of the cube nor the gravitational mass of the cube

27.

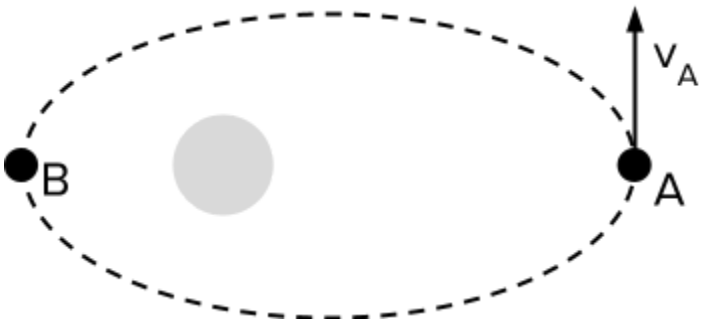



A 3.8 kg cube is connected to a massless ideal spring of spring constant 300 N/m and oscillates horizontally on a frictionless floor as seen above left. The position x (measured from equilibrium) of the cube as a function of time is given by the graph above right. The maximum speed of the mass is closest to which of the following choices?

(A) 0.4 m/s
(B) 0.8 m/s
(C) 1.2 m/s
(D) 1.6 m/s

28.




A planet of mass M moves in an elliptical orbit around a star as seen in the diagram above. At point A the planet is moving with speed $v_A$ and is a distance $r_A$ away from the center of the star. How fast is the planet moving when it is at point B, a distance $r_B$ away from the star?

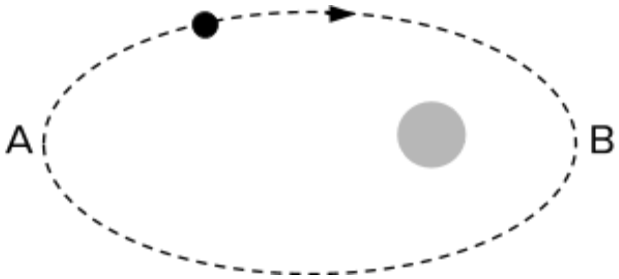
(A) $v_A(\frac{r_B}{r_A})$

(B) $v_A(\frac{r_A}{r_B})$

(C) $Mv_A(\frac{r_B}{r_A})$

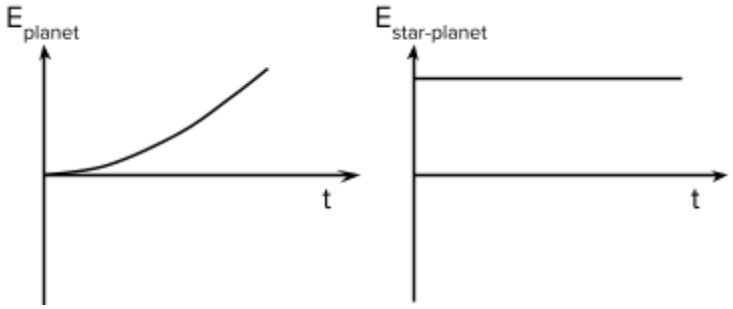
(D) $Mv_A(\frac{r_A}{r_B})$

29.

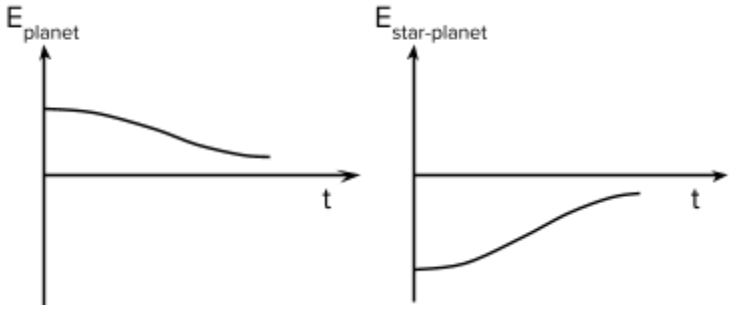



A planet is orbiting a star in an elliptical orbit as seen in the diagram above. Which of the following pairs of graphs best represents the mechanical energy of just the planet and the total mechanical energy of the star-planet system during the time it takes the planet to move from point A to point B?

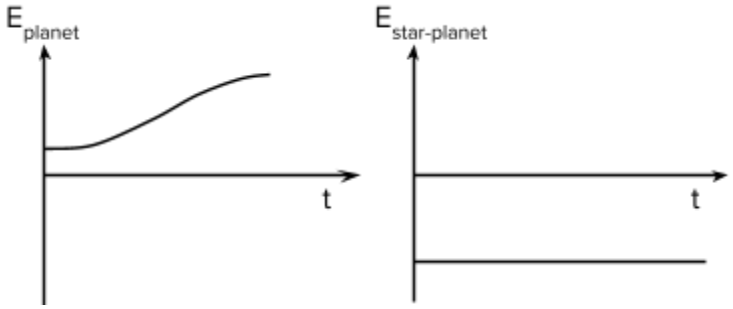
(A)



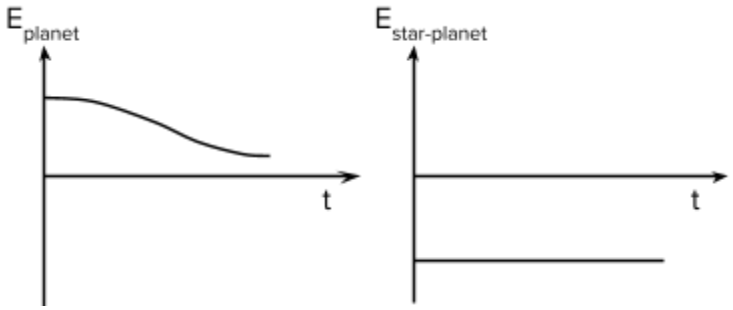

(B)




(C)

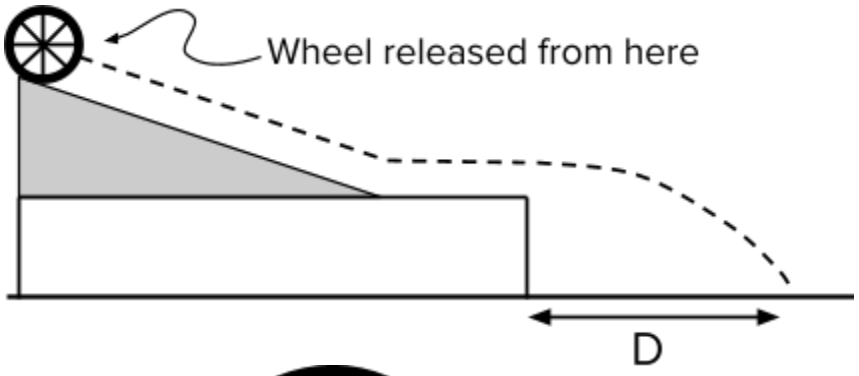



(D)

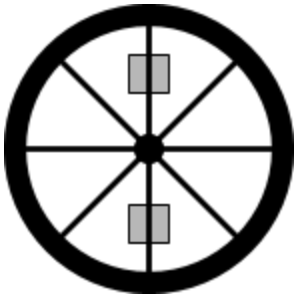


30.

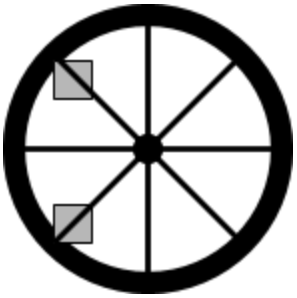
A student will roll a bicycle wheel from rest down a ramp, allowing it to fly off the end of a horizontal table, and measures the distance traveled D before it hits the ground as seen to the right. The student will attach two square gray masses to the spokes of the bicycle wheel. Which one of the following choices for gray mass location would allow the wheel to achieve the largest distance D?



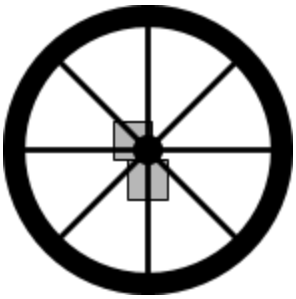

(A)



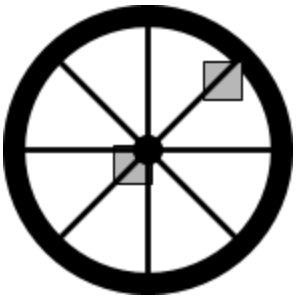
(B)



(C)



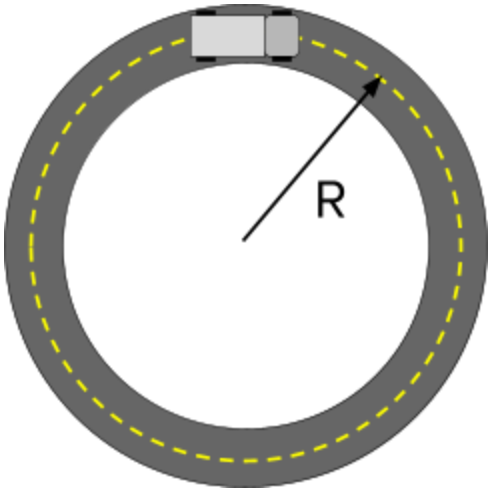
(D)



***For the following questions 31-32, you are required to select two correct choices***

31.

A truck is driving in a circle around a roundabout with constant speed without slipping as seen in the bird's eye view to the right. A student knows the mass of the truck. Which two of the following quantities together, in addition to the mass of the truck, would allow the student to determine the force of friction being exerted on the truck's tires as it drives in the circle? Select two.




(A) Radius of the roundabout
(B) Coefficient of static friction
(C) Magnitude of the acceleration due to gravity (g)
(D) Speed of the truck

32.

A satellite moves in a circular orbit with constant speed around a stationary planet. Assume the mass of the planet is much, much larger than the satellite. What two statements are most correct about the scenario? Select two.

(A) The planet is doing positive work on the satellite
(B) The momentum of the satellite is conserved
(C) The total energy of the satellite-planet system is conserved
(D) The satellite is accelerating

Answers:

Approximate score breakdown (75%=5, 60%=4, 50%=3, 40%=2)

1. D
2. C
3. C
4. D
5. A
6. B
7. C
8. A
9. B
10. A
11. B
12. D
13. A
14. A
15. A
16. B
17. C
18. A
19. D
20. D
21. D
22. A
23. A
24. C
25. C
26. C
27. B
28. B
29. C
30. C
31. A,D
32. C,D