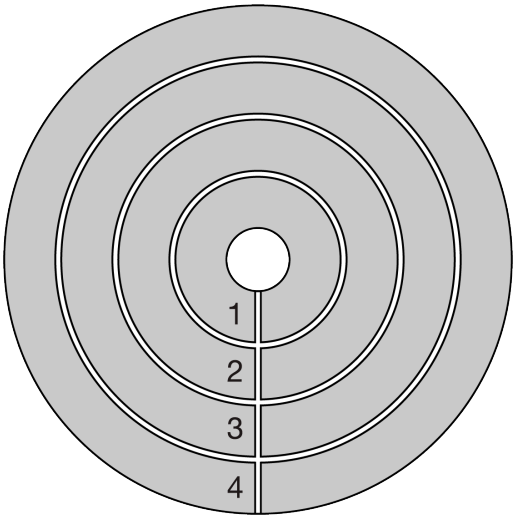
Unit 3 Progress Check: MCQ Part B

A horizontal, circular track for running has four lanes, as shown in the figure. Various runners of different masses use the track. In each case, the center of mass of a runner follows a circular path around the track in one of the lanes.



1. Consider a runner in lane 1 with a speed v_1 and a runner in lane 4 with a speed v_4, where the ratio of the speeds v_4/v_1 is 2. The radius of lane 4 is b times the radius of lane 1, and both runners have the same mass. Which of the following claims is correct about the net forces F_1 and F_4 exerted on the runners in lanes 1 and 4, respectively?

(A) F_4 is equal to $\frac{2}{b}F_1$.

(B) F_4 is equal to $\frac{4}{b}F_1$. ✓

(C) F_4 is equal to $\frac{2}{b^2}F_1$.

(D) F_4 is equal to $\frac{4}{b^2}F_1$.

2. Consider a runner in any of the lanes moving at a known, constant tangential speed. Which of the following measuring tools, if any, could be used to experimentally determine the centripetal acceleration of the runner?

(A) A force probe

(B) A protractor

(C) A meterstick ✓

(D) None of these measuring tools, by themselves, can be used with the known tangential speed to determine the centripetal acceleration of the runner.

Unit 3 Progress Check: MCQ Part B

3. Now consider four runners running around the track with the same constant tangential speed, with one runner in each lane of the track. A student is considering using the following equations to determine which runner has the greatest acceleration.

Equation 1: $v_x^2 = v_{x0}^2 + 2a_x\left(x - x_0\right)$

Equation 2: $a_c = \frac{v^2}{r}$

Which equation should the student use, and why?

(A) Equation 1, because the runners all have the same speed.

(B) Equation 1, because the different distances traveled by the runners in a complete lap around the track determine which runner has the greatest acceleration.

(C) Equation 2, because the acceleration term has already been isolated on the left-hand side of the equation.

(D) Equation 2, because the radius of the circular path traveled by a runner determines the acceleration of the runner. ✓

Unit 3 Progress Check: MCQ Part B

4.

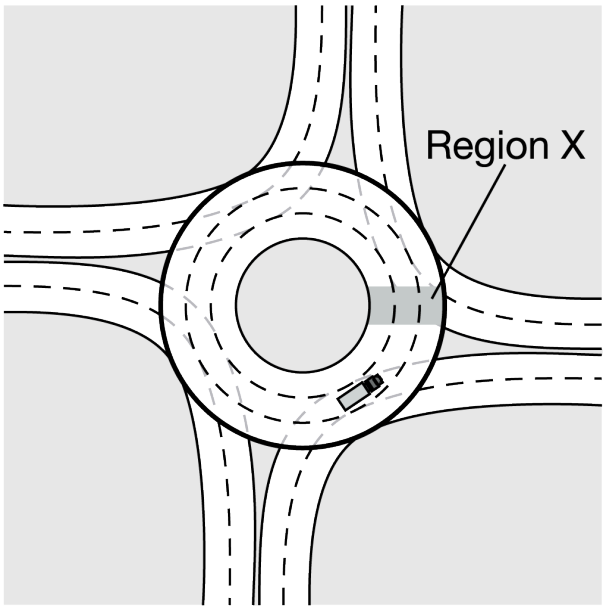


Figure 1

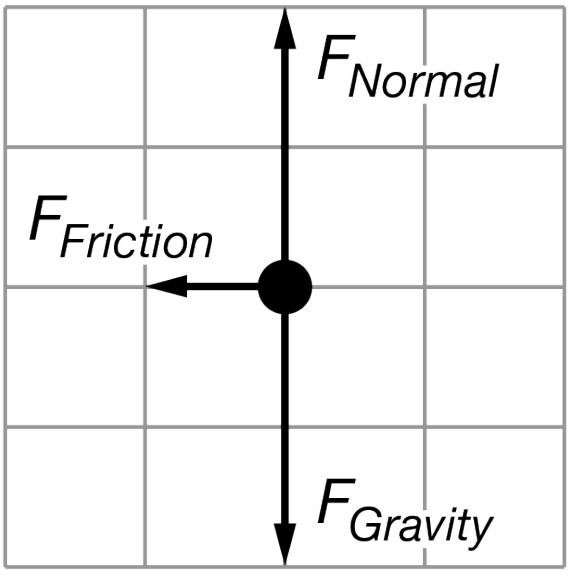


Figure 2

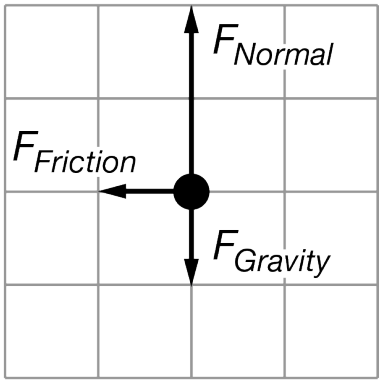
A truck in a traffic circle travels in a circular path at constant speed v_0 while passing through region X of the circle, as shown in Figure 1 above. A diagram representing the forces exerted on the truck in region X is shown in Figure 2. At a later time a car with less mass than the truck passes through region X at the same speed and the same

Unit 3 Progress Check: MCQ Part B

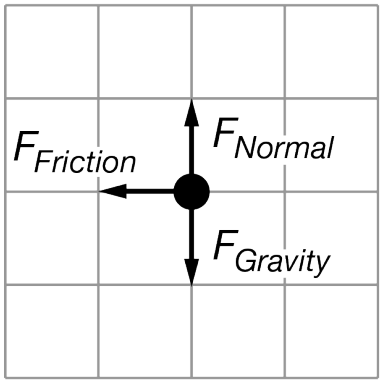
distance from the center of the traffic circle as the truck. The coefficient of friction between the car's tires and the ground is the same as that for the truck's tires and the ground. Which of the following diagrams could represent the forces exerted on the car in region X compared to the truck in region X ? Assume that the length of each arrow is proportional to the magnitude of the force represented by the arrow.

Unit 3 Progress Check: MCQ Part B

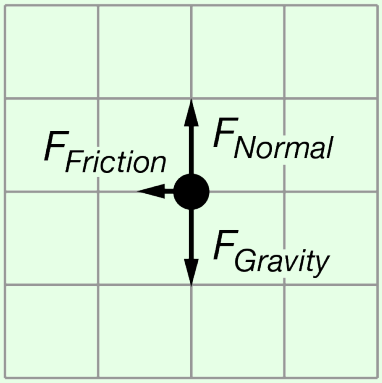
(A)



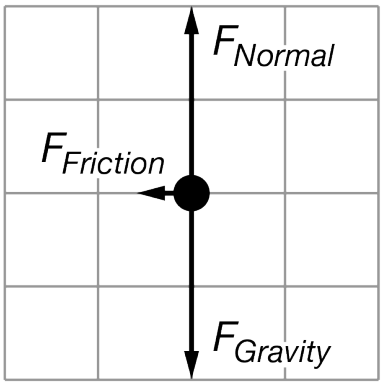
(B)



(C) ✓

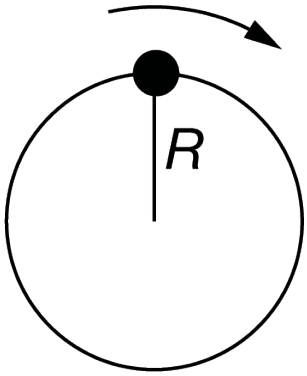


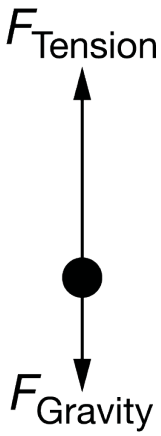
(D)



Unit 3 Progress Check: MCQ Part B

5.





A student swings a ball of mass M on the end of a string in a vertical circle of radius *R*, as shown in the top figure above. Also shown is a diagram representing all of the forces exerted on the ball at the *bottom* of the circle, where its speed is v_0. What is the magnitude of the acceleration of the ball at the *bottom* of the circle?

(A) $\frac{F_{\text{Tension}}}{M}$

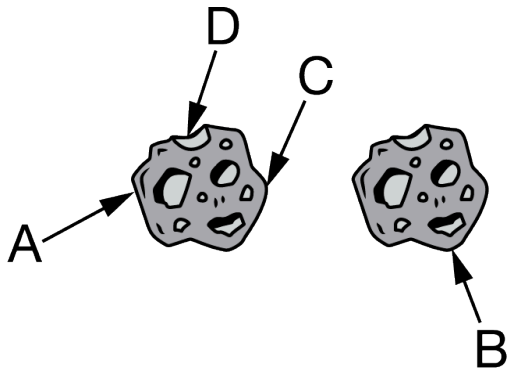
(B) $\frac{F_{\text{Gravity}}}{M}$

(C) $\frac{F_{\text{Tension}} + F_{\text{Gravity}}}{M}$

(D) $\frac{F_{\text{Tension}} - F_{\text{Gravity}}}{M}$ ✓

Unit 3 Progress Check: MCQ Part B

6.



The figure above shows two identical asteroids that are located near each other but are not in contact. Various locations are also labeled on the asteroids. If an astronaut wants to stand on one of the asteroids and experience the largest net gravitational force, where should the astronaut stand?

(A) Location A ✓

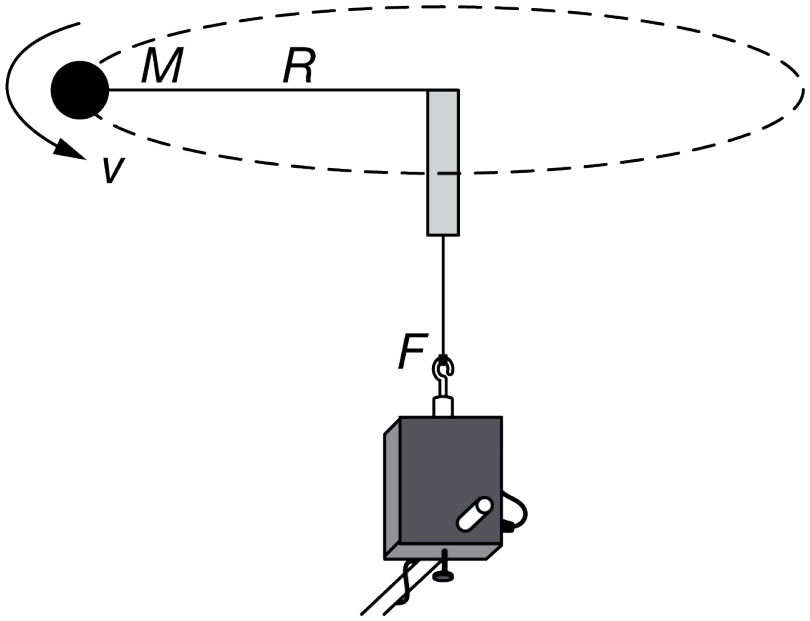
(B) Location B

(C) Location C

(D) Location D

Unit 3 Progress Check: MCQ Part B

7.



Centripetal Force for Varied Mass with Constant Radius and Speed		Centripetal Force for Varied Radius with Constant Mass and Speed		Centripetal Force for Varied Speed with Constant Radius and Mass	
Mass (kg)	Force (N)	Radius (m)	Force (N)	Speed $(\mathrm{m/s})$	Force (N)
0.1	4.0	0.6	4.0	2.0	4.0
0.2	8.0	0.3	8.0	3.0	9.0
0.3	12.0	0.2	12.0	4.0	16.0

A student conducts three experiments to determine how certain quantities influence the centripetal force responsible for an object to spin in a horizontal circle. The student uses one end of a string to attach the object while the other end is connected to a force sensor that allows the student to change the tension on the string, as shown in the figure. The student records data from the three experiments in the table above. Which of the following experiments, if any, collected data that do not agree with the expression for the net centripetal force on the object?

(A) The experiment in which mass was changed

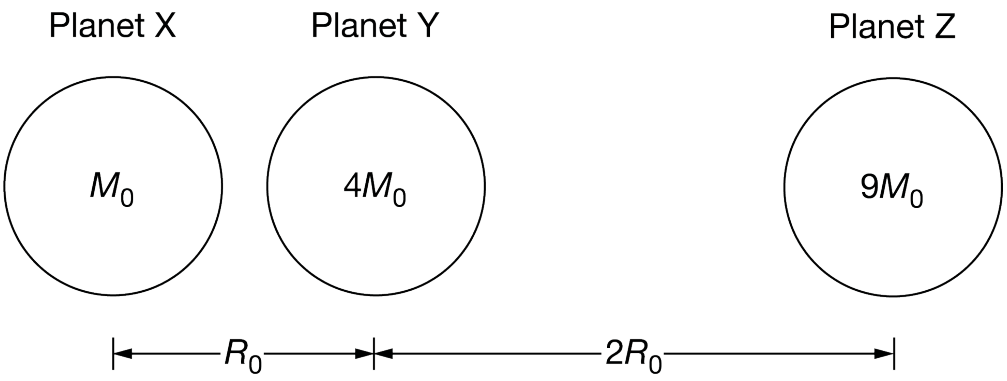
(B) The experiment in which the radius of the circular path was changed

(C) The experiment in which the speed of the object was changed

(D) All the data are expected. ✓

Unit 3 Progress Check: MCQ Part B

8.



At one point in their individual orbits, three planets, X, Y, & Z, are along the same horizontal line. The gravitational force on Planet X from Planet Z is F_0. The distance from the center of mass of each planet to an adjacent planet is given in terms of R_0, and their respective masses are given in terms of M_0, as shown above. What is the net force on Planet Y, and what reasoning supports this claim?

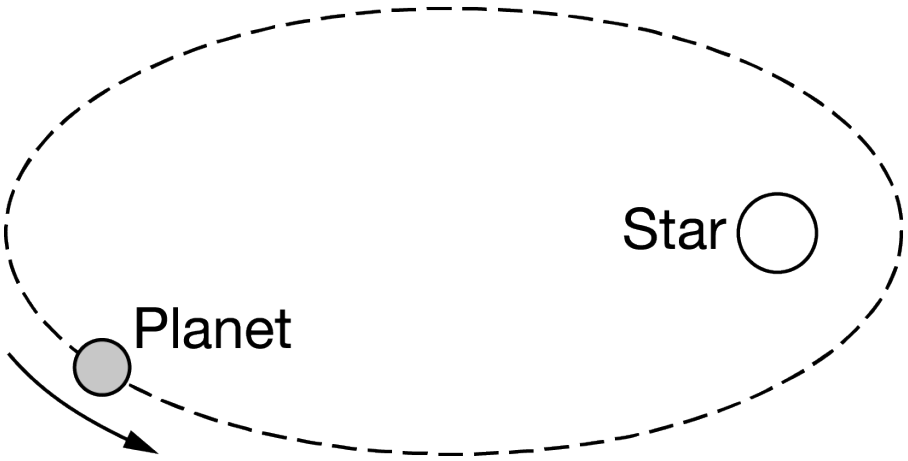
(A) F_0 to the left, because the gravitational force from Planet X is greater than the gravitational force from Planet Z.

(B) $32F_0$ to the left, because the gravitational force from Planet X is greater than the gravitational force from Planet Z.

(C) $5F_0$ to the right, because the gravitational force from Planet Z is greater than the gravitational force from Planet X. ✓

(D) $13F_0$ to the right, because the gravitational force from Planet Z is greater than the gravitational force from Planet X.

9.

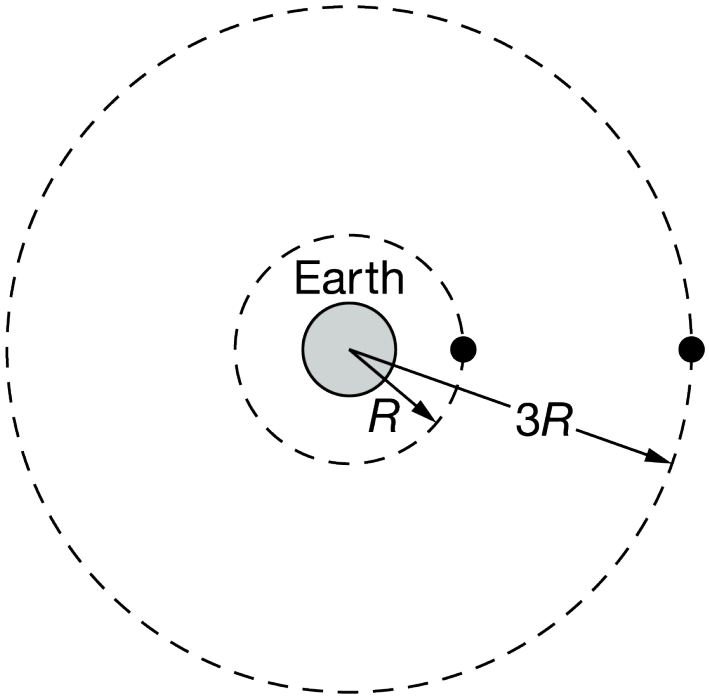


A planet orbits a star in the path shown in the figure. The planet's mass is much smaller than the star's mass. Which two of the following claims are correct about the accelerations associated with the planet, star, and planet-star system? Select two answers. Justify your selections.

Unit 3 Progress Check: MCQ Part B

A	Both the planet and the star accelerate, because each object exerts a force on the other object.	✓
B	Only the planet accelerates, because a force is exerted on the planet but not on the star.	
C	The center of mass of the planet-star system accelerates, because the planet and star exert forces on each other.	
D	The center of mass of the planet-star system does not accelerate, because there is no net force exerted on the system.	✓

10.



A satellite moves in a circular orbit at a constant speed v_0 around Earth at a distance R from its center. The force exerted on the satellite is F_0. An identical satellite orbits Earth at a distance of $3R$ from the center of the Earth. How does the tangential speed, v_T, of the satellite at distance $3R$ compare to the speed v_0 of the satellite at R?

(A) $v_T = 3v_0$

(B) $v_T = \frac{1}{3}v_0$

(C) $v_T = \sqrt{3v_0}$

(D) $v_T = \frac{1}{\sqrt{3}}v_0$ ✓

Unit 3 Progress Check: MCQ Part B

11.

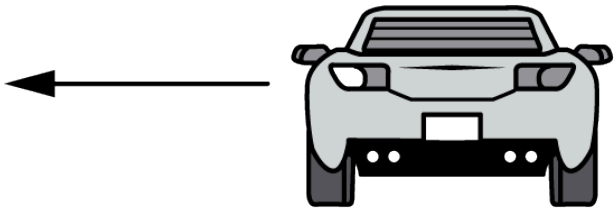


Figure 1.
Rear View, Car Turning Left

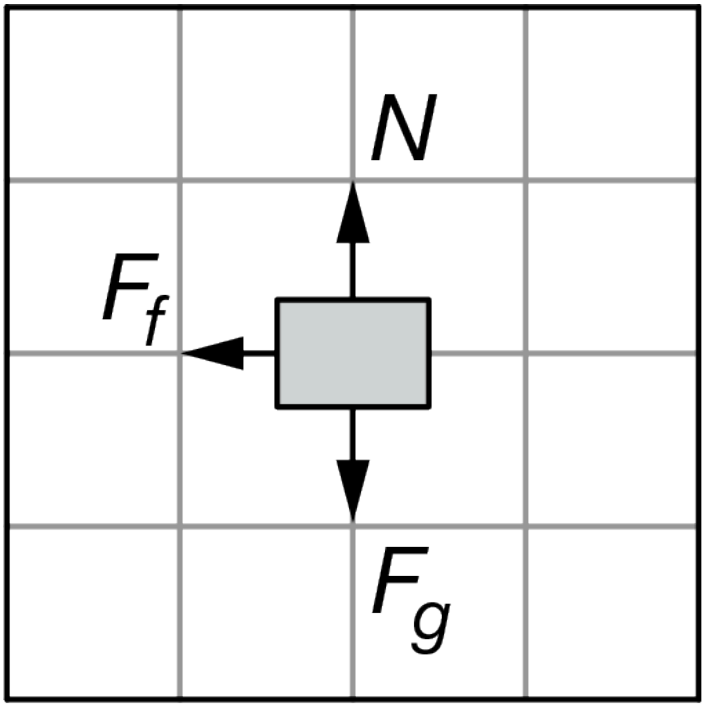


Figure 2

Unit 3 Progress Check: MCQ Part B

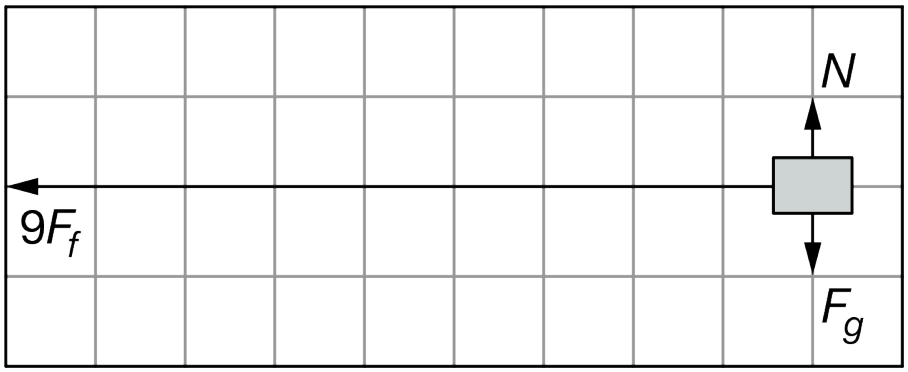


Figure 3

A car travels with a tangential speed v_1 around a curve of radius r and turns to the left, as shown by the rear view of the car in Figure 1. A force diagram of the forces exerted on the car with speed of $5\ \mathrm{m/s}$ as it turns is shown in Figure 2. A force diagram of the forces exerted on the car with speed v as it turns around the same curve of the same radius is shown in Figure 3. The speed v of the car in figure 3 is most nearly

(A) $1.5\ \mathrm{m/s}$

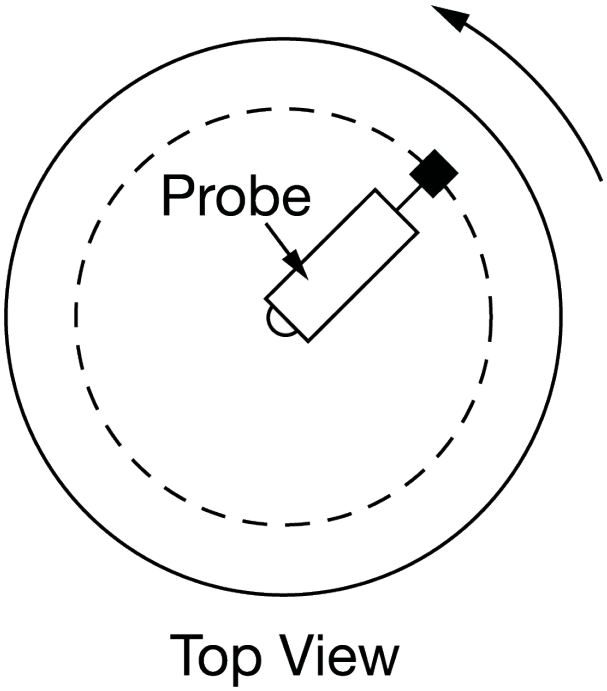
(B) $4.5\ \mathrm{m/s}$

(C) $15\ \mathrm{m/s}$ ✓

(D) $35\ \mathrm{m/s}$

Unit 3 Progress Check: MCQ Part B

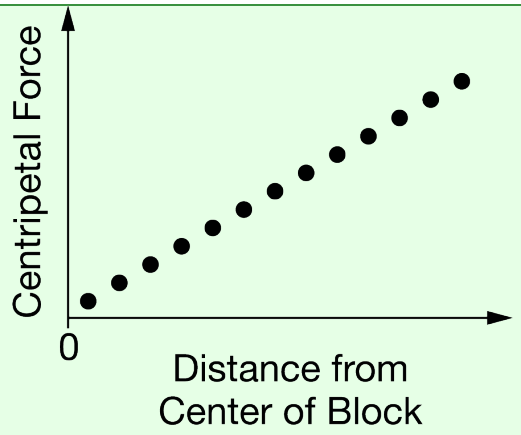
12.



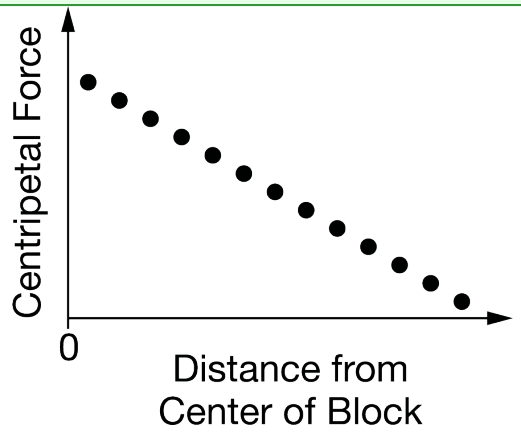
A student places a block on a disk, and the edge of the disk makes one revolution in a constant time interval $\triangle t$. A force probe is attached to the block and the center of the disk, as shown above. In an experiment, a student measures the centripetal force exerted on the block when placed at various distances from the center of the disc while the tangential speed of the edge of the disc remains constant. Which of the following graphs shows the centripetal force exerted on the block as a function of its distance from the center of the disk?

Unit 3 Progress Check: MCQ Part B

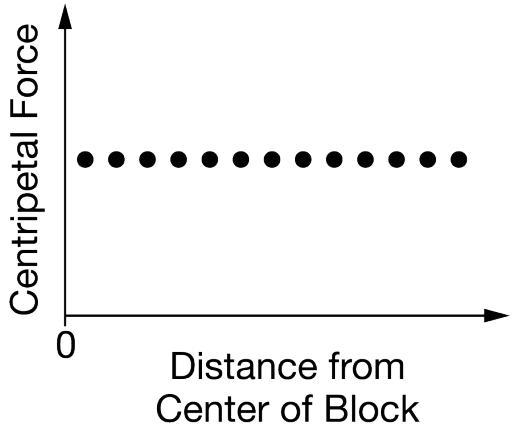
(A)



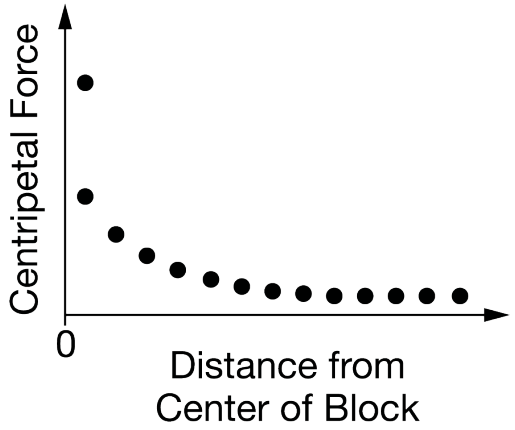
(B)



(C)

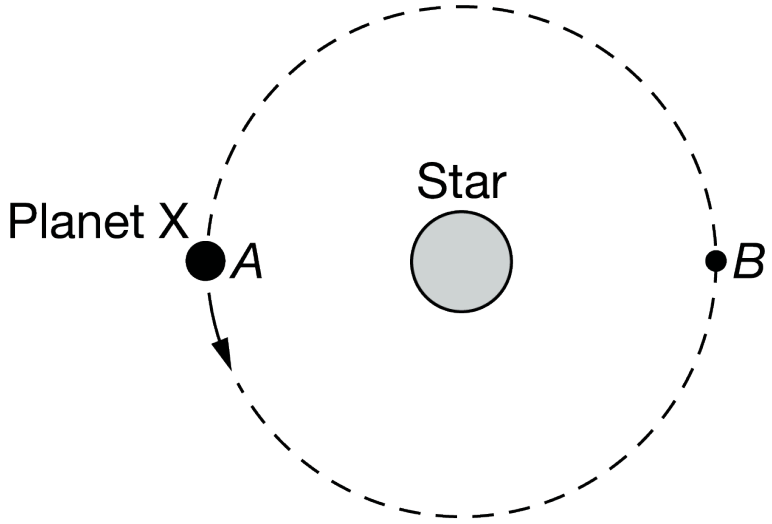


(D)



Unit 3 Progress Check: MCQ Part B

13.



Note: Figure not drawn to scale.

Planet X is in a stable circular orbit around a star, as shown above. Which of the following graphs best shows the tangential speed of the planet as a function of its horizontal position from point A to point B if the planet is moving counter clockwise as viewed in the figure above?

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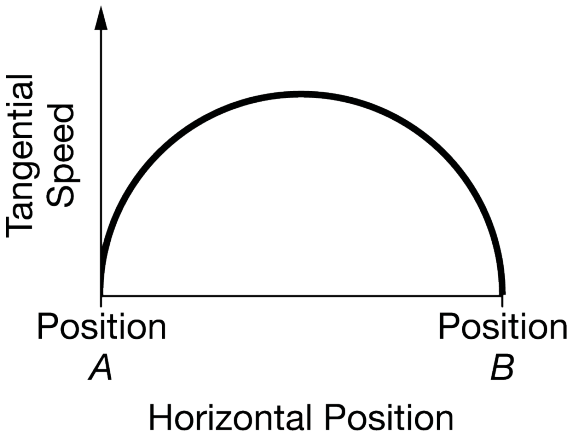
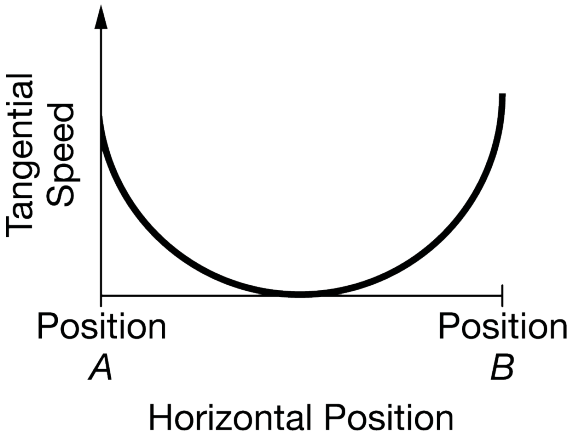
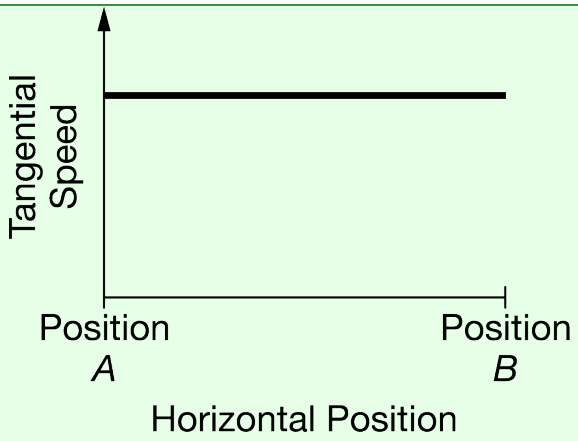
(A)



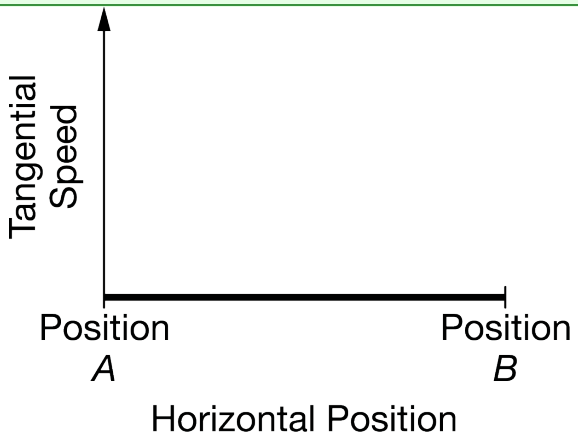
(B)



(C) ✓



(D)



Unit 3 Progress Check: MCQ Part B

14. One end of a string is attached to a ball, with the other end held by a student such that the ball is swung in a horizontal circular path of radius R at a constant tangential speed. At a later time, the tension force exerted on the ball remains constant, but the length of the string is decreased to $\frac{R}{4}$. What is the new tangential speed of the ball?

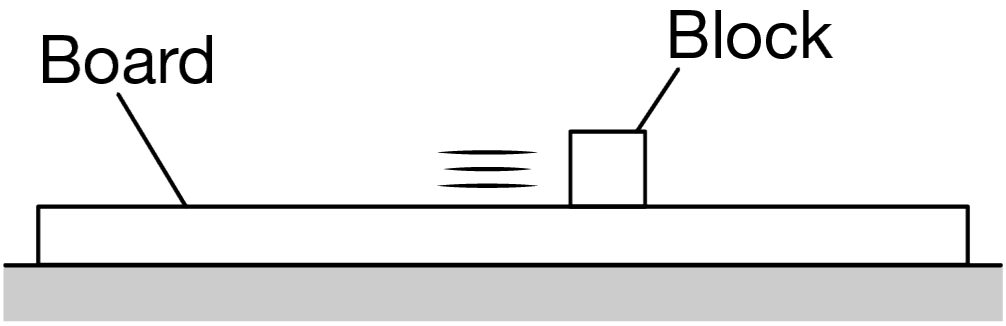
(A) Four times the original speed

(B) Two times the original speed

(C) Half the original speed ✓

(D) One-fourth the original speed

15.



A long wooden board is at rest on a horizontal surface, and there is negligible friction between the board and the surface. A block is sliding along the board, and there is friction between the block and the board. At the instant shown in the figure, the block is moving but the board is still at rest. What happens to the board and block after the instant shown, and what reasoning supports this claim?

(A) The board starts moving in the same direction as the block and the block is slowing down, because the board exerts a force on the block and the block exerts a force on the board. ✓

(B) The board remains at rest and the block is slowing down, because the board exerts a force on the block.

(C) The board starts moving in the same direction as the block and the block continues to move at the same speed, because the block exerts a force on the board.

(D) The board remains at rest and the block continues to move at the same speed, because the board exerts a force on the block and the block exerts a force on the board and both forces are constant.

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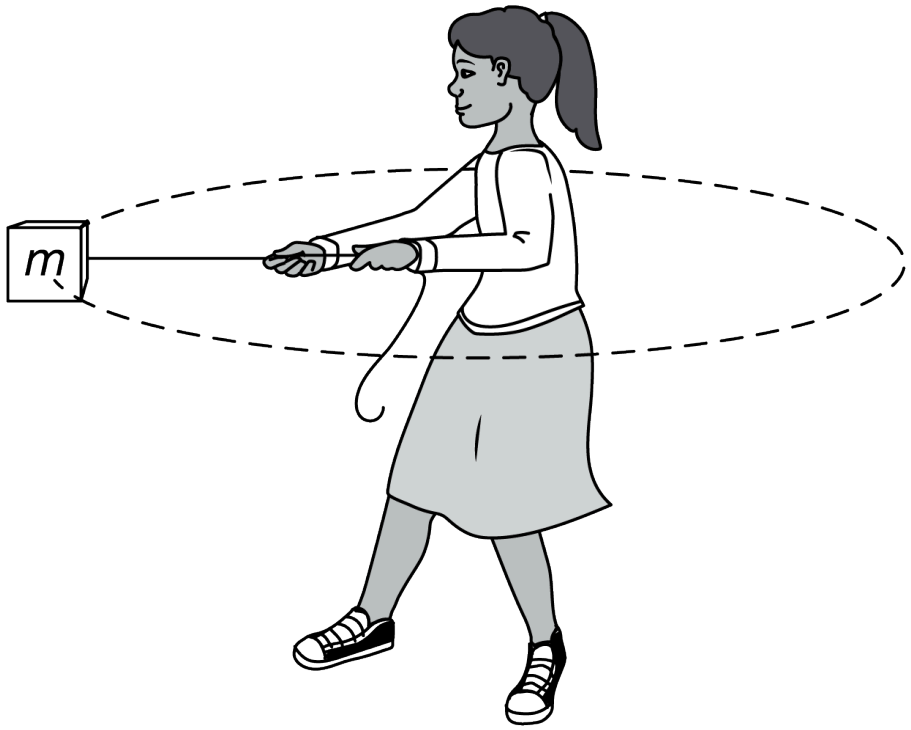
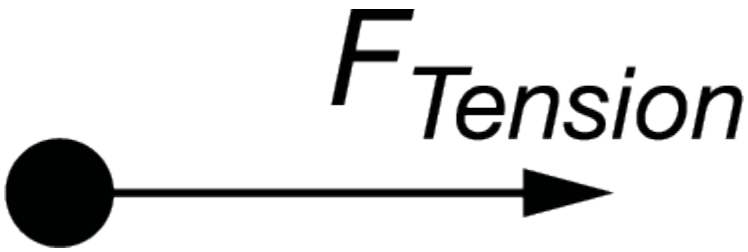
16.





A student must test the maximum force exerted on an object attached to a string before the string breaks. The student ties the object of mass m_0 to one end of the string and then uses the other end of the string to spin the object at a constant speed so that the object travels in a horizontal circular path, as seen in Figure 1. Figure 2 shows the horizontal force exerted on the object at time t_0. In a second trial, what should the student do to increase the tension in the string while keeping all other quantities constant? Select two answers.

A	Increase the mass of m_0.	✓
B	Increase the length of string.	
C	Decrease the time required for one rotation.	✓
D	Decrease the height of m_0 above the floor.	

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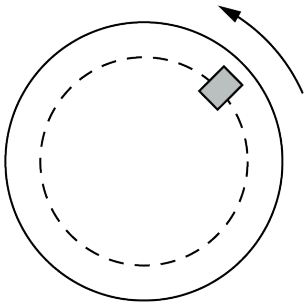
17.



Top View

A block is at rest on a disk that spins about its center, as shown. A student must determine the centripetal acceleration of the block when the block spins with the disk as a result of the force of static friction. What measuring devices, when used together, could be used to determine the centripetal acceleration of the block? Select two answers.

A Mass balance

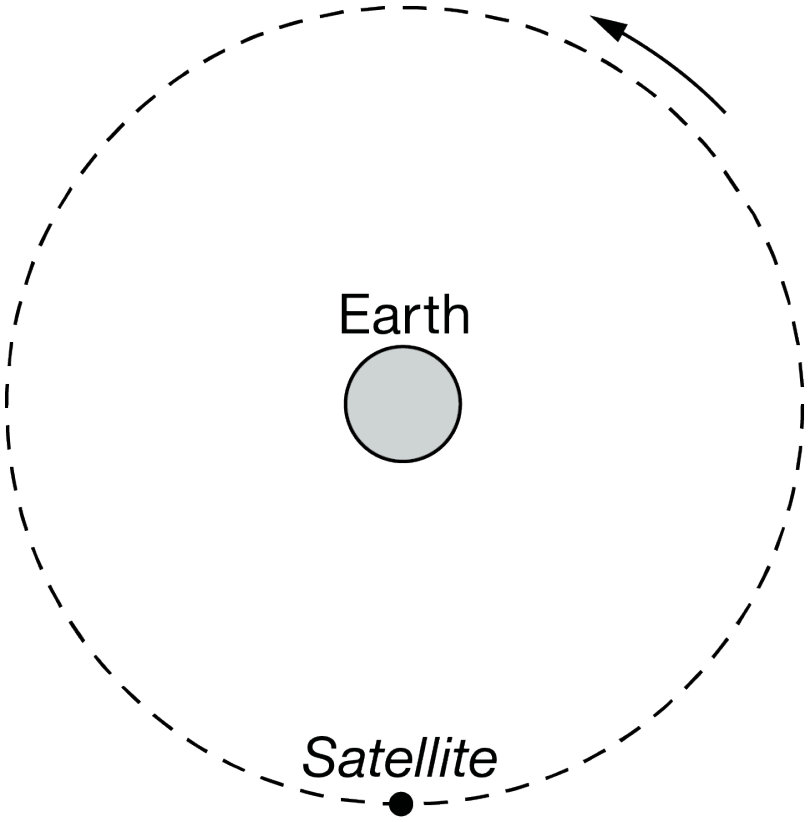
B Meterstick ✓

C Stopwatch ✓

D Motion sensor

Unit 3 Progress Check: MCQ Part B

18.



A satellite orbits Earth in a circular path at a constant tangential speed, as shown in the figure. Which of the following correctly represents the directions of the net force $\mathrm{F_{Net}}$, acceleration a, and tangential velocity $\mathrm{v_T}$ of the satellite at the instant shown in the figure?

Unit 3 Progress Check: MCQ Part B

(A)

F_{Net}	a	v_T
↑	↑	→

(B)

F_{Net}	a	v_T
↑	→	→

(C)

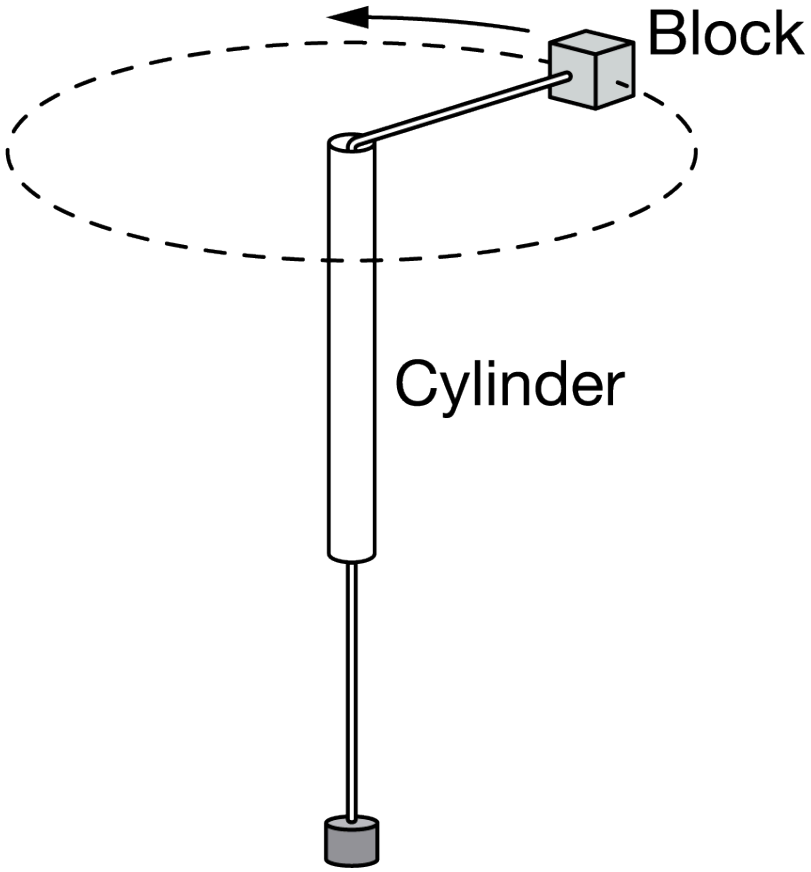
F_{Net}	a	v_T
↑	→	↑

(D)

F_{Net}	a	v_T
↓	↓	→

Unit 3 Progress Check: MCQ Part B

19.



A square block is attached to a string of negligible mass and moves in a horizontal circle at a constant speed. The string passes through a vertical tube, and its other end is attached to a cylinder, as shown in the figure. Which of the following claims can be made by relating one of Newton's laws of motion to an object that travels in uniform circular motion?

(A) The block exerts a force on the string. ✓

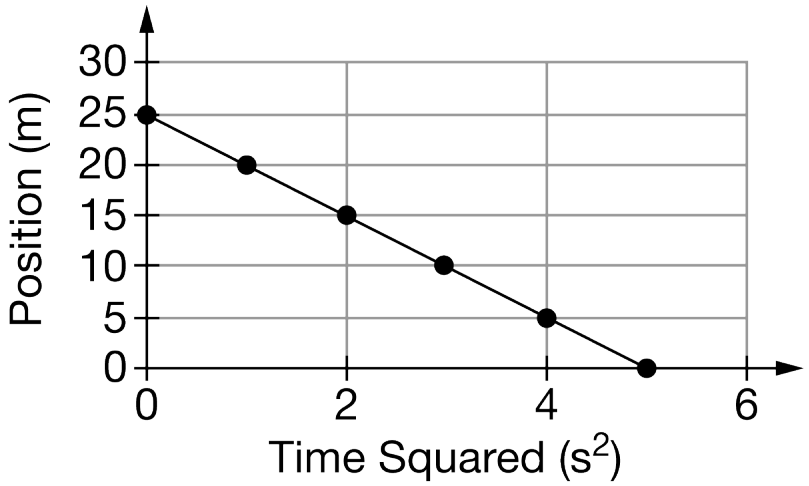
(B) The block exerts a contact force on the cylinder.

(C) The cylinder exerts a contact force on the block.

(D) The forces exerted on the string are negligible.

Unit 3 Progress Check: MCQ Part B

20.



An object falls toward Earth after it is released from rest, as a result of Earth's gravitational force. A student uses a motion detector to create the graph of the object's displacement as a function of the squared time in which the object was in free fall. How can the student use the graph to determine the acceleration a_y of the object while in free fall?

(A) Use the slope of the graph and set it equal to a_y.

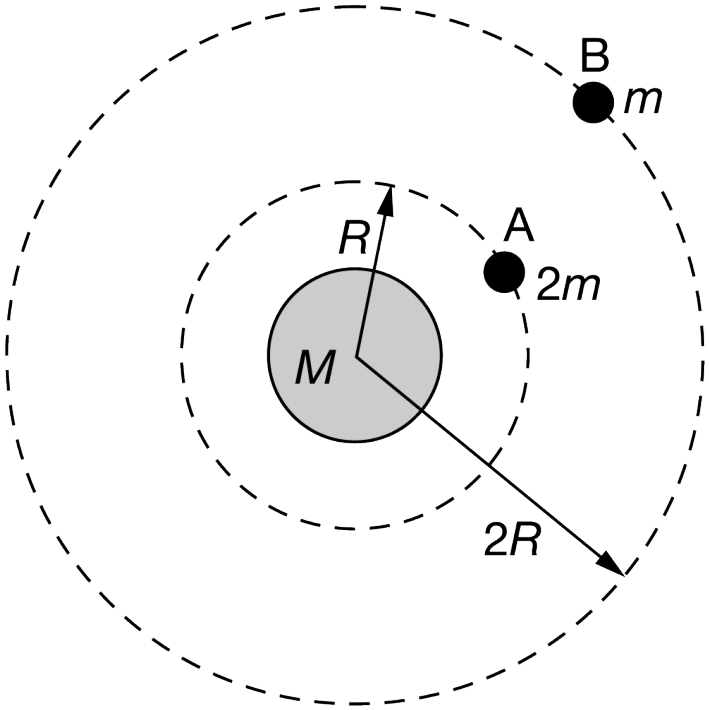
(B) Use the slope of the graph and set it equal to $\frac{1}{2}a_y$ to then solve for a_y. ✓

(C) Use the area under the curve and set it equal to a_y.

(D) Use the area under the curve and set it equal to $2\,a_y$ to then solve for a_y.

Unit 3 Progress Check: MCQ Part B

21.



Two satellites orbit a planet of mass M, as shown above. Satellite A of mass $2\,m$ travels in a circular orbit of radius R. Satellite B of mass m travels in a circular orbit of radius $2\,R$. Each satellite travels at a constant tangential speed. How does the gravitational force, $F_{g\mathrm{A}}$, exerted on satellite A from the planet compare with the gravitational force, F_{gB}, exerted on satellite B from the planet?

(A) $F_{g\mathrm{A}}$ is larger than $F_{g\mathrm{B}}$ because satellite A is twice as large as satellite B and is half the distance to the planet as satellite B. ✓

(B) $F_{g\mathrm{A}}$ is smaller than $F_{g\mathrm{B}}$ because satellite B must travel at a greater tangential speed than satellite A in order to complete one revolution in the same time that satellite A completes one revolution.

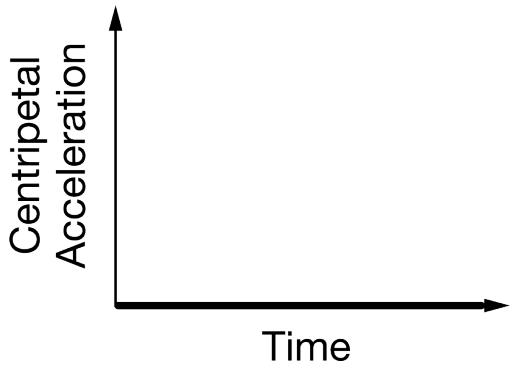
(C) $F_{g\mathrm{A}}$ is the same as $F_{g\mathrm{B}}$ because both satellites have a net force that is toward the center of mass of the planet.

(D) $F_{g\mathrm{A}}$ is the same as $F_{g\mathrm{B}}$ because satellite A is twice as large as satellite B and satellite B is twice as far away from the planet as satellite A.

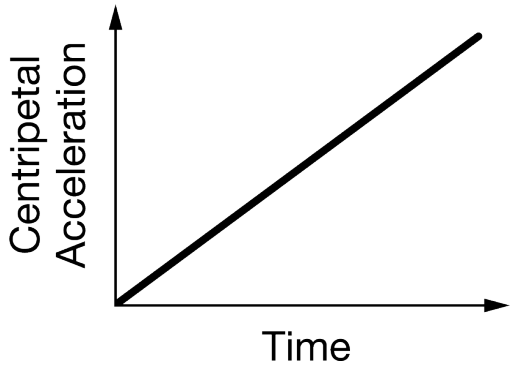
22. An object starts at rest and moves in a horizontal circle such that its tangential speed increases linearly as a function of time. Which of the following graphs shows how the centripetal acceleration behaves as a function of time?

Unit 3 Progress Check: MCQ Part B

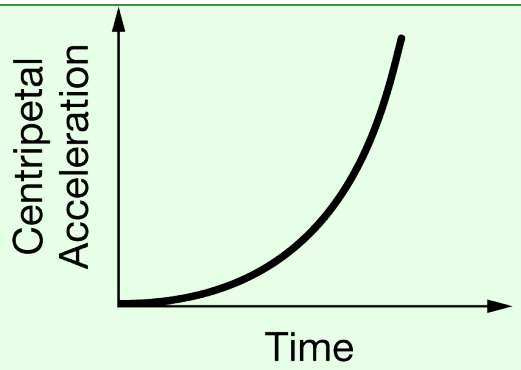
(A)



(B)



(C) ✓



(D)

