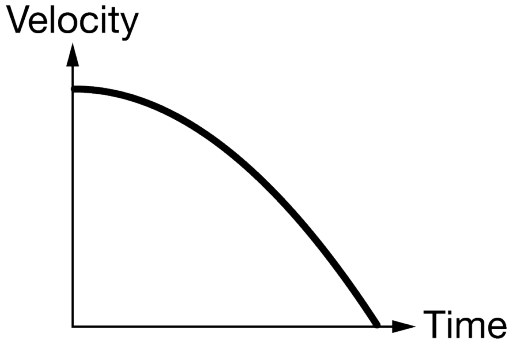
Unit 1 Progress Check: MCQ

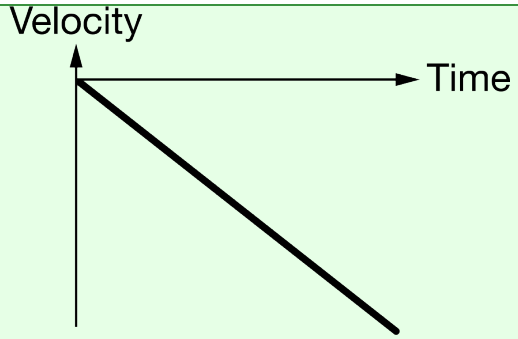
Rock X is released from rest at the top of a cliff that is on Earth. A short time later, Rock Y is released from rest from the same location as Rock X. Both rocks fall for several seconds before landing on the ground directly below the cliff. Frictional forces are considered to be negligible.

1. Which of the following graphs correctly shows the vertical velocity of rock X as a function of time? Take the positive direction to be upward.

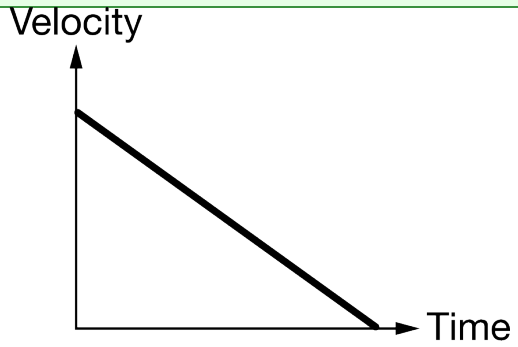
(A)



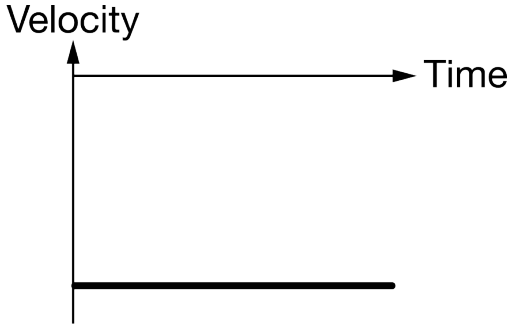
(B) ✓



(C)



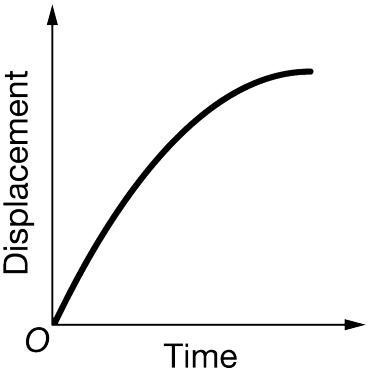
(D)



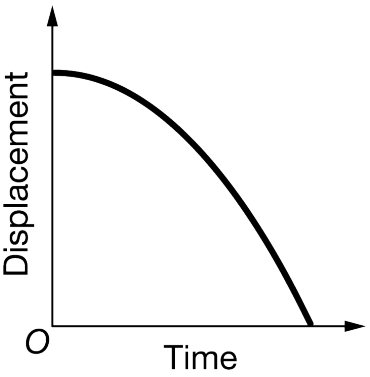
Unit 1 Progress Check: MCQ

2. Which of the following graphs best represents the vertical displacement of Rock X as a function of time starting from immediately after the rock is released from rest? Take the positive direction to be downward.

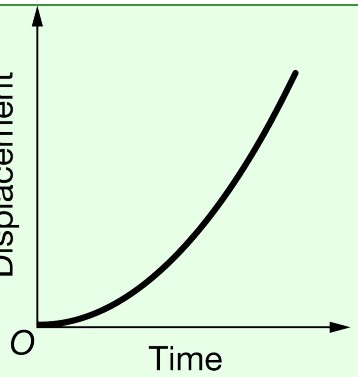
(A)



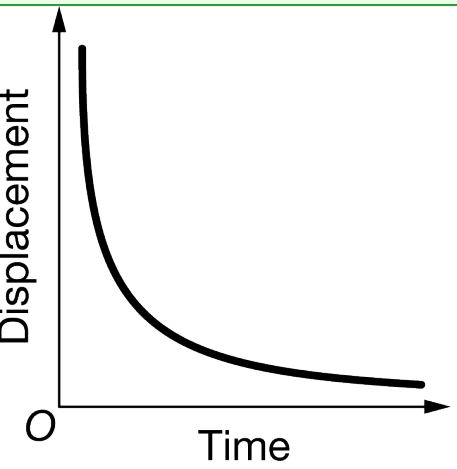
(B)



(C) ✓



(D)



Unit 1 Progress Check: MCQ

3. After Rock Y is released from rest several seconds after Rock X is released from rest, what happens to the separation distance S between the rocks as they fall but before they reach the ground, and why? Take the positive direction to be downward.

(A) S is constant because at the moment Rock Y is released, the only difference between the rocks is their difference in height above the ground.

(B) S is constant because the difference in speed between the two rocks stays constant as they fall.

(C) S increases because the difference in speed between the two rocks increases as they fall.

(D) S increases because at all times Rock X falls with a greater speed than Rock Y. ✓

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4. Toy car W travels across a horizontal surface with an acceleration of a_w after starting from rest. Toy car Z travels across the same surface toward car W with an acceleration of a_z after starting from rest. Car W is separated from car Z by a distance d. Which of the following pairs of equations could be used to determine the location on the horizontal surface where the two cars will meet, and why?

(A) $x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$ for car W, and $x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$ for car Z. Since the cars will meet at the same time, solving for t in one equation and placing the new expression for t into the other equation will eliminate all unknown variables except x. ✓

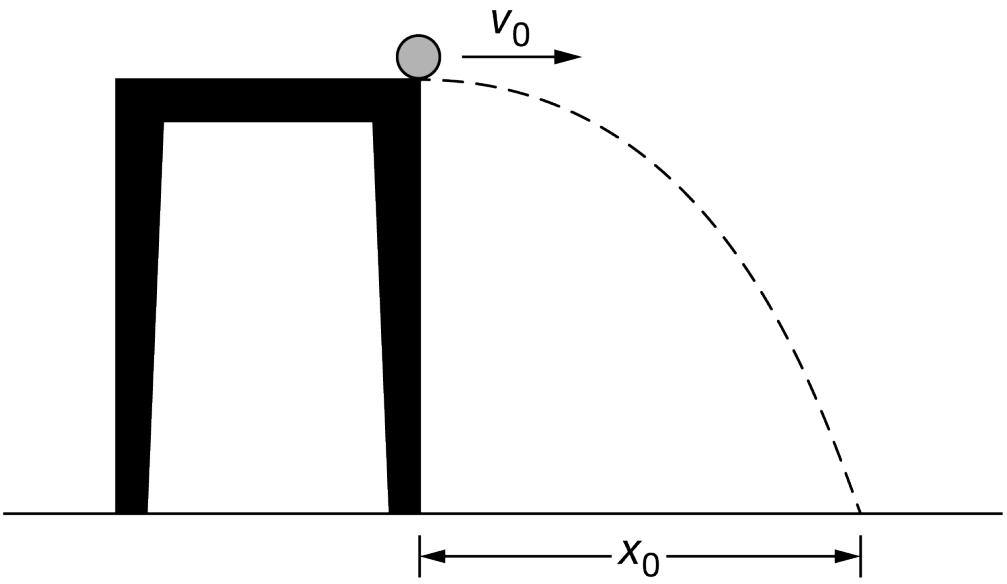
(B) $x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$ for car W, and $\Delta x = x - x_0$ for car Z. Since the separation distance is known between both cars, the displacement for car Z can be used in the equation for car W so that the time at which the cars meet can be determined. Once known, the time can be used to determine the meeting location.

(C) $\Delta x = x - x_0$ for car W, and $x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$ for car Z. Since the separation distance is known between both cars, the displacement for car W can be used in the equation for car Z so that the time at which the cars meet can be determined. Once known, the time can be used to determine the meeting location.

(D) $\Delta x = x - x_0$ for car W, and $\Delta x = x - x_0$ for car Z. Since the location at which the cars meet represents the final position of both cars, the separation distance for both cars can be substituted into both equations to determine the final position of both cars.

Unit 1 Progress Check: MCQ

5.



A ball traveling at a speed v_0 rolls off a desk and lands at a horizontal distance x_0 away from the desk, as shown in the figure. The ball is then rolled off of the same desk at a speed of $3\,v_0$. At what horizontal distance will the ball land from the table?

(A) x_0

(B) $3x_0$ ✓

(C) $6x_0$

(D) $9x_0$

6. A student drops a rock from rest at a distance h above the ground such that the rock hits the ground at time t_0. At what distance above the ground should the rock be dropped such that it hits the ground at a time $2t_0$ after it is released from rest?

(A) h

(B) $2h$

(C) $3h$

(D) $4h$ ✓

Unit 1 Progress Check: MCQ

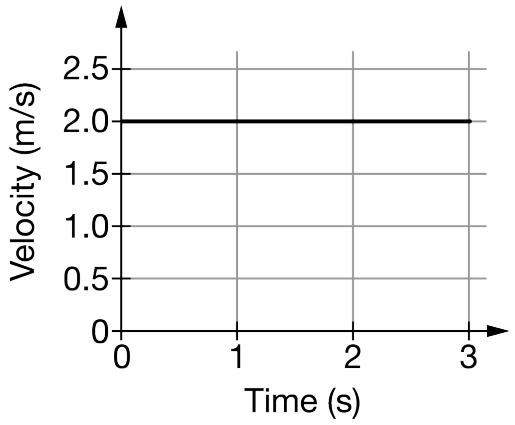
7.

Time (s)	Position (m)
0	0
1	3
2	8
3	15

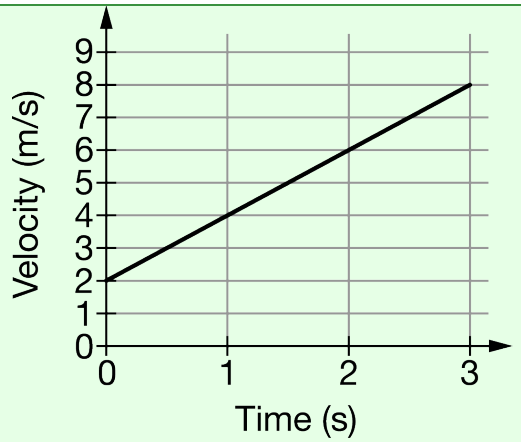
An object travels along a straight, horizontal surface with an initial speed of $2\ \frac{\mathrm{m}}{\mathrm{s}}$. The position of the object as a function of time is given in the table. Which of the following graphs represents the object's velocity as a function of time?

Unit 1 Progress Check: MCQ

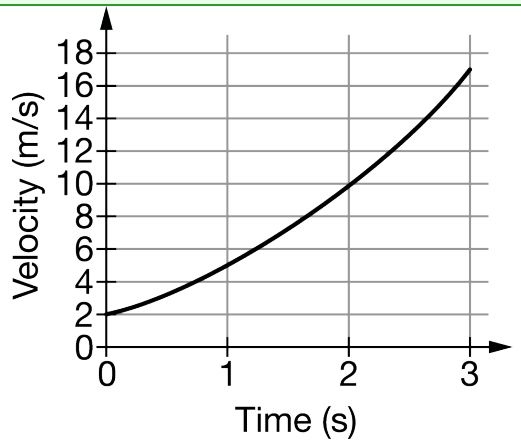
(A)



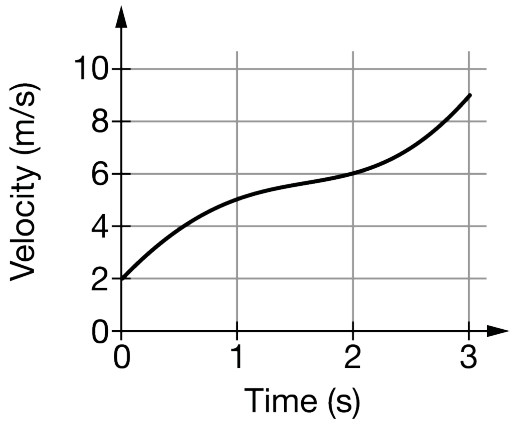
(B) ✓



(C)



(D)



Unit 1 Progress Check: MCQ

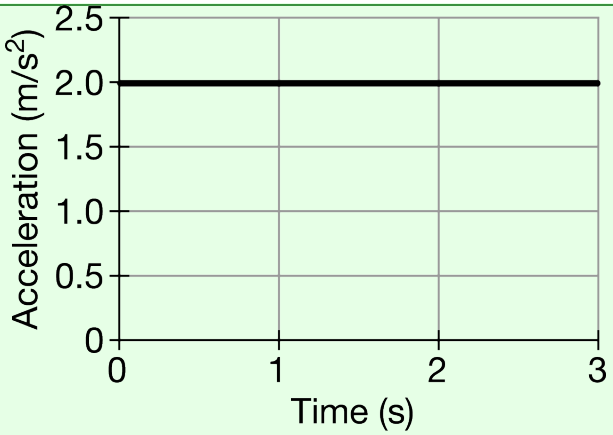
8.

Time (s)	Velocity (m)
0	2
1	4
2	6
3	8

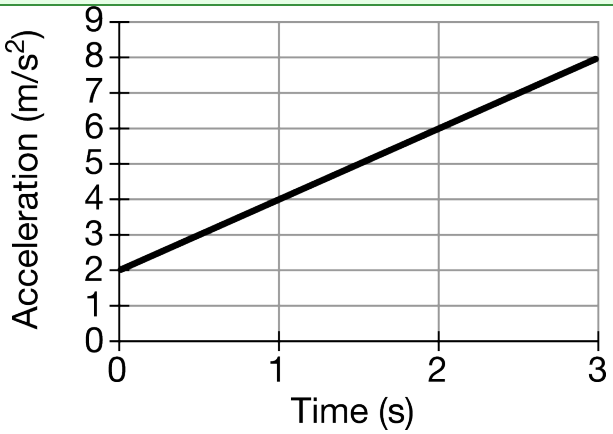
An object travels along a straight, horizontal surface with an initial speed of $2\ \frac{\mathrm{m}}{\mathrm{s}}$. The velocity of the object as a function of time is given in the table above. Which of the following graphs represents the object's acceleration as a function of time?

Unit 1 Progress Check: MCQ

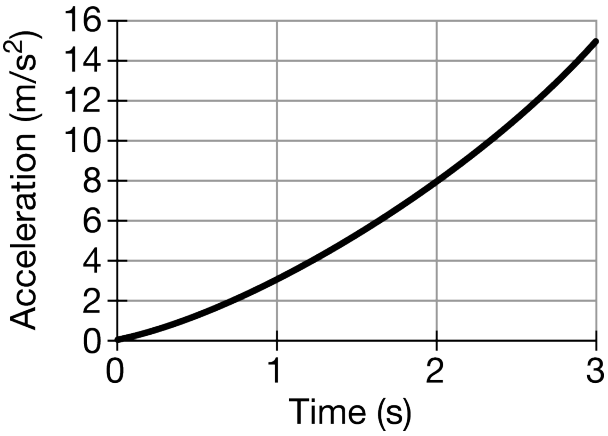
(A)



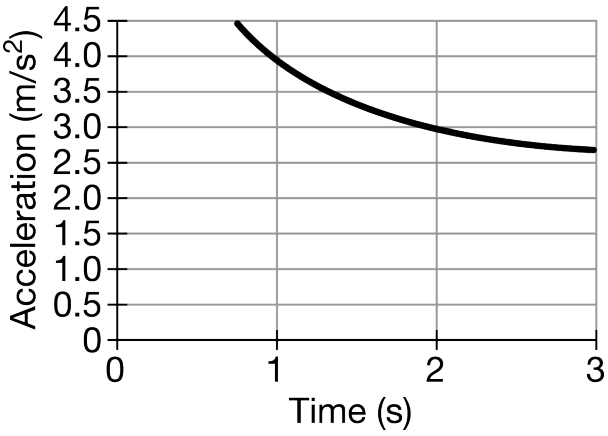
(B)



(C)

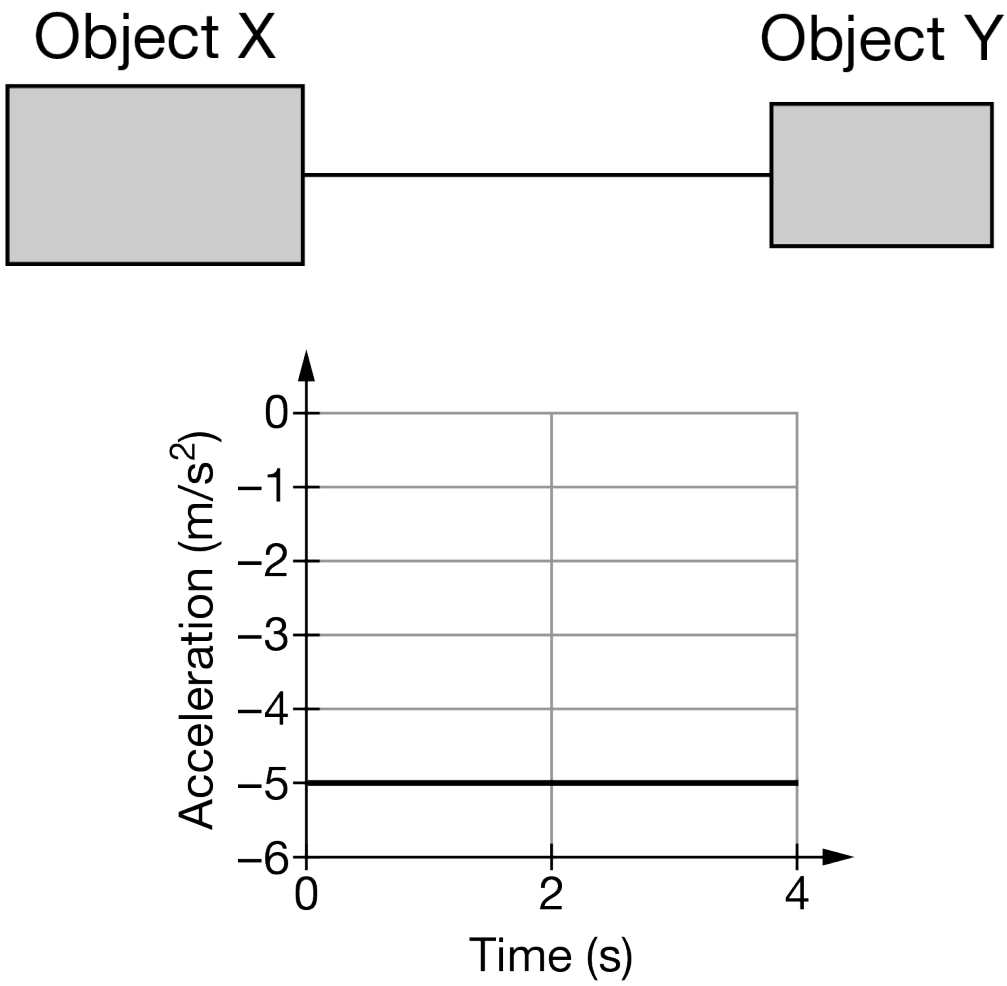


(D)



Unit 1 Progress Check: MCQ

9.



Two objects, object X and object Y, are held together by a light string and are released from rest near a planet's surface in the orientation that is shown in the figure. Object X has a greater mass than object Y. A graph of the acceleration as a function of time for the system's center of mass is shown for the $4\mathrm{s}$. The positive direction is considered to be upward. How does the speed of object X v_x compare to that of the system's speed v_s after the objects have fallen for $4\mathrm{s}$?

(A) $v_x = v_s$ ✓

(B) $v_x > v_s$

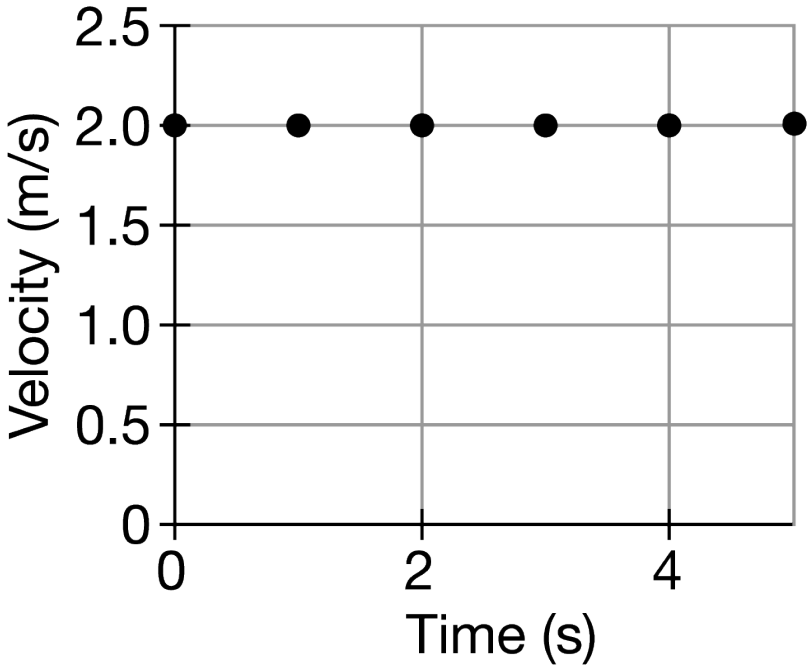
(C) $v_x < v_s$

(D) The answer cannot be determined without knowing the relative masses of object X and object Y.

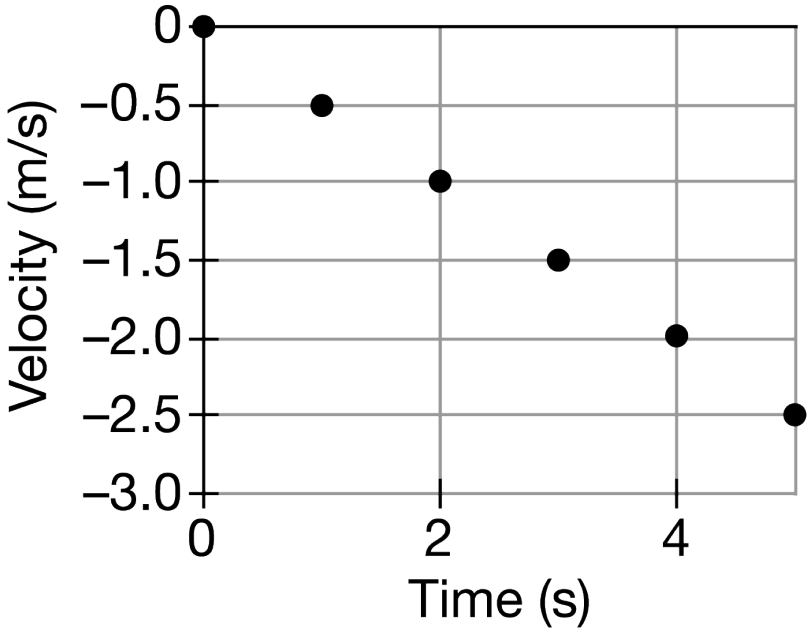
Unit 1 Progress Check: MCQ

10.

Trial 1



Trial 2



A student uses a motion sensor to collect data of the velocity of an object as a function of time during two experimental trials, as shown. In which trial does the object have the greatest magnitude of acceleration, and in which trial does the object travel the greatest distance?

Unit 1 Progress Check: MCQ

(A)

Greatest Magnitude of Acceleration	Greatest Distance
Trial 1	Trial 1

(B)

Greatest Magnitude of Acceleration	Greatest Distance
Trial 2	Trial 2

(C)

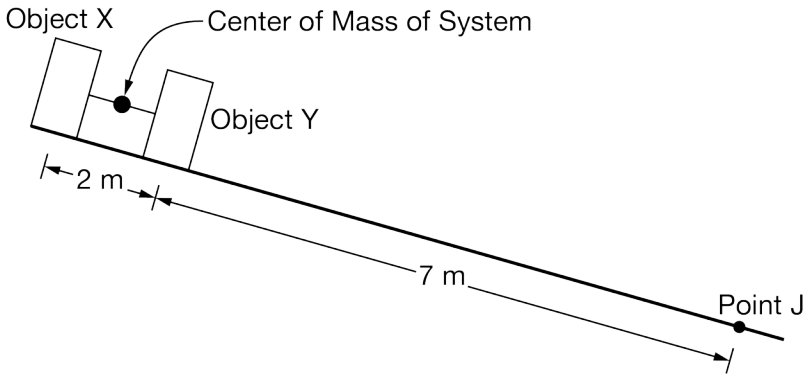
Greatest Magnitude of Acceleration	Greatest Distance
Trial 1	Trial 2

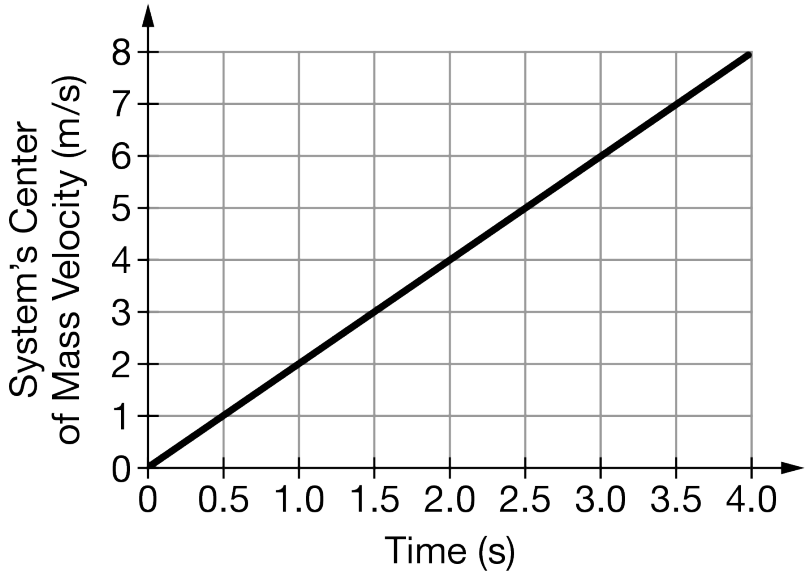
(D) ✓

Greatest Magnitude of Acceleration	Greatest Distance
Trial 2	Trial 1

Unit 1 Progress Check: MCQ

11.





Identical objects, Object X and Object Y, are tied together by a string and placed at rest on an incline, as shown in the figure. The distance between the center of mass of each object is $2\ \mathrm{m}$. The system of the two objects is released from rest, and a graph of the system's center of mass velocity as a function of time is shown. Based on the data, approximately how much time will it take the center of mass of Object X to reach point J near the bottom of the incline?

(A) $2.7\ \mathrm{s}$

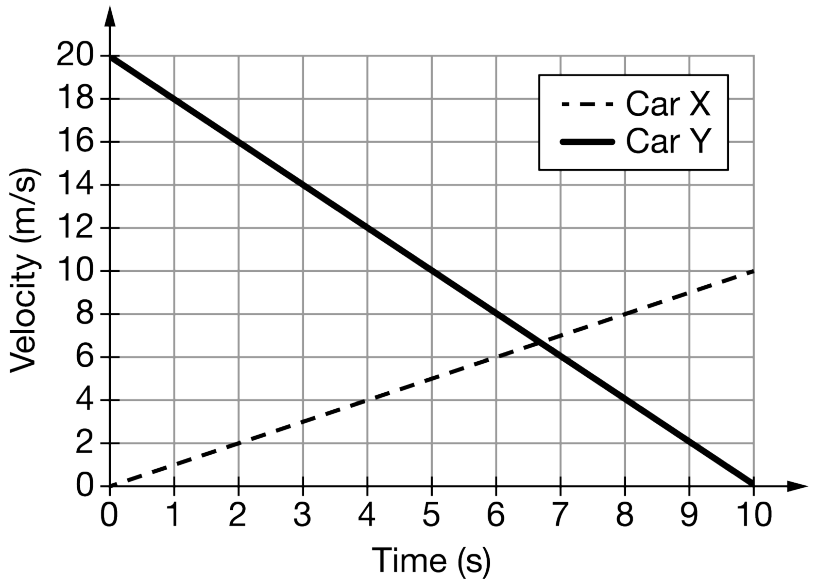
(B) $2.8\ \mathrm{s}$

(C) $3.0\ \mathrm{s}$ ✓

(D) $3.5\ \mathrm{s}$

Unit 1 Progress Check: MCQ

12.



Car X and car Y travel on a horizontal surface along different parallel, straight paths. Each car's velocity as a function of time is shown in the graph. Which of the following claims is correct about car X and car Y?

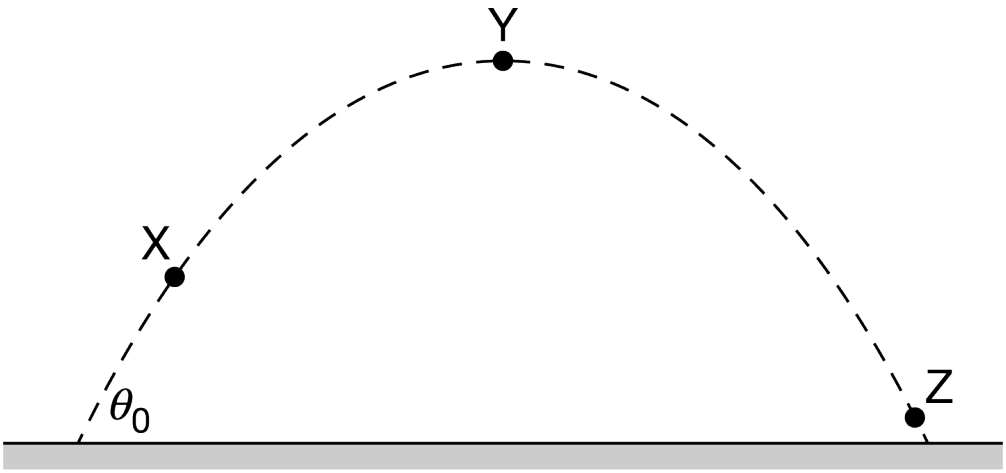
(A) Both car X and car Y travel in the same direction. ✓

(B) Between $t = 6\,\text{s}$ and $t = 7\,\text{s}$, car X and car Y are at the same horizontal position.

(C) The change in car X's speed per unit of time increases as the time increases, and the change in car Y's speed per unit of time decreases as the time increases.

(D) The magnitude of the acceleration of car X is the same as the magnitude of the acceleration of car Y.

13.



An object is launched upward at angle θ_0 above the horizontal with a speed of v_0. The trajectory and three positions of the object, X, Y, and Z, are shown in the figure. Position X is higher than position Z with respect to the ground, and position Y is at the object's maximum vertical position. Which of the following claims is correct about the system that consists of only the object?

Unit 1 Progress Check: MCQ

(A) The speed of the object at position X is greater than the speed of the object at position Z.

(B) The object's speed at point Z is v_0.

(C) The object's acceleration is the same at positions X, Y, and Z. ✓

(D) The object is at rest at position Y.

14.

Time (s)	Vertical Position (m)
0.0	5.0
0.3	4.7
0.5	3.8
0.8	2.2
1.0	0.1

The table shows the vertical position as a function of time for an object that is dropped from a height of 5 m. A student must determine the acceleration of the object. Which of the following procedures could the student use to make the determination? Justify your selections. Select two answers.

A Create a graph of y as a function of t^2, since the slope will be equal to the acceleration due to gravity.

B Use $\overline{v_y} = \frac{\Delta y}{\Delta t}$ to determine the average vertical speed of the ball, and then divide the average speed by the time in which the ball was in the air, since the average speed and time interval is used to determine an object's acceleration.

C Use $y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$, since all quantities are known except for the acceleration due to gravity. ✓

D Create a position-versus-time graph of the ball's motion, and use the data to create a velocity-versus-time graph of the ball's motion, since the slope of the velocity-versus-time graph represents the acceleration. ✓

15. A student must design an experiment to determine the acceleration of a cart that rolls down a small incline after it is released from rest. The student has access to a timer, a meterstick, and a slow-motion camera that takes a photograph every $\frac{1}{60}$ of a second. The angle that the incline makes with the horizontal is unknown, and the length of the incline is unknown. Which of the following procedures could the student use to determine the cart's acceleration? Select two answers.

A Use the meterstick to measure the vertical height of the incline, and use the timer to record the time it takes for the cart to travel down the incline.

B Use the timer to record the time it takes the cart to travel alongside a meterstick that is attached to the incline. ✓

C Use the slow-motion camera to film the cart as it rolls down the incline alongside a meterstick that is attached to the incline. ✓

D Use the slow-motion camera to film the cart as it rolls down the incline alongside a timer that is attached to the incline.

Unit 1 Progress Check: MCQ

16. An object is held at an unknown height above Earth's surface, where the acceleration due to gravity of the object is considered to be constant. After the object is released from rest, a student must determine the object's speed the instant the object makes contact with the ground. Which of the following equations could the student use to determine the object's speed by using the fewest measuring tools if the student does not have access to a motion sensor? Select two answers.

A $v_x = v_{x0} + a_x t$ ✓

B $x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$

C $v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$ ✓

D $\overline{v} = \frac{x - x_0}{t}$