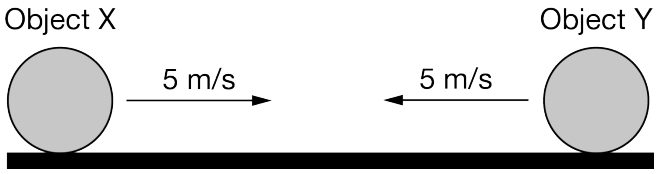
Unit 5 Progress Check: MCQ Part A



Two objects of the same mass travel in opposite directions along a horizontal surface. Object X has a speed of $5\ \frac{m}{s}$ and object Y has a speed of $5\ \frac{m}{s}$, as shown in the figure. After a period of time, object X collides with object Y. In scenario 1, the objects stick together after the collision. In scenario 2, the objects do not stick together after the collision.

1. Which of the following claims is true regarding how the outcome of scenario 1 is different from the outcome of scenario 2?

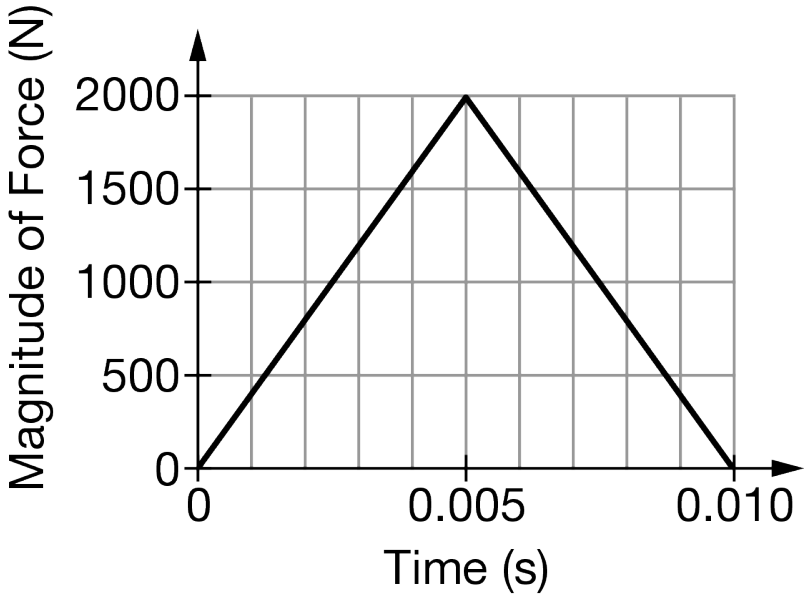
(A) The total momentum of the system in scenario 1 will be less than that in scenario 2 after the collision.

(B) The total momentum of the system in scenario 1 will be more than that in scenario 2 after the collision.

(C) The kinetic energy of the system in scenario 1 will be less than that in scenario 2 after the collision. ✓

(D) The kinetic energy of the system in scenario 1 will be more than that in scenario 2 after the collision.

2.



Object X collides into object Y and exerts a force on object Y while both objects are in contact. A graph of the force that object X exerts on object Y is shown. How could the graph be used to determine the change in momentum of object Y during the collision?

(A) By multiplying the maximum force by the time during which the entire force was applied

(B) By dividing the maximum force by the time during which the entire force was applied

(C) By determining the magnitude of the slope of the line before 0.005 s and after 0.005 s

(D) By determining the area bound by the curve and the horizontal axis from 0 s to 0.01 s ✓

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3. Consider scenario 1. Is the object X–object Y system open or closed? Predict whether both the momentum and the kinetic energy of the system will be the same or different after the collision.

(A)

Type of System	Momentum	Kinetic Energy
Open	Same	Same

(B)

Type of System	Momentum	Kinetic Energy
Open	Changes	Changes

(C) ✓

Type of System	Momentum	Kinetic Energy
Closed	Same	Changes

(D)

Type of System	Momentum	Kinetic Energy
Closed	Changes	Same

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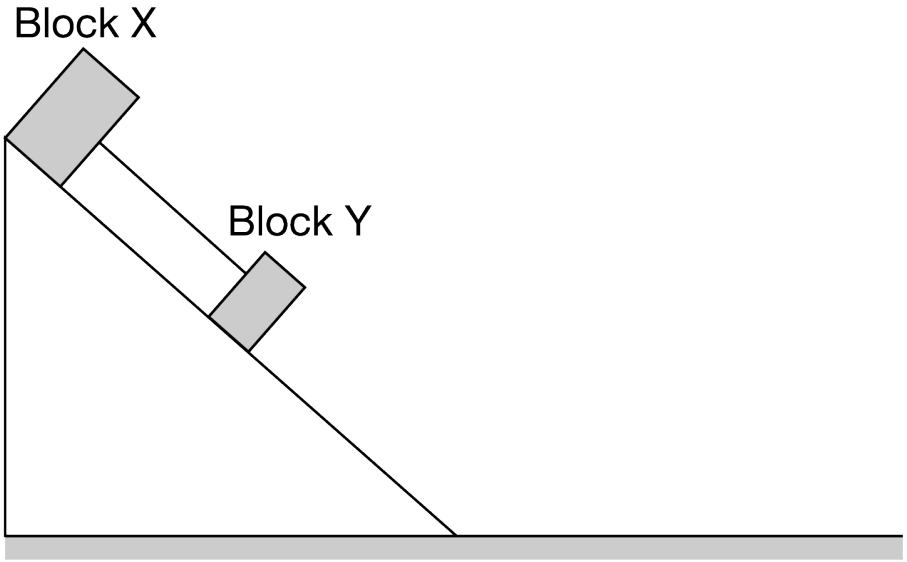
4.



Block X and block Y are tied together by a rope. The system containing block X and block Y is released from rest on a ramp, as shown in the figure. Block Y has a smaller mass than block X. Which of the following claims is correct regarding the momentum of the system containing only block X and the system that contains block X and block Y?

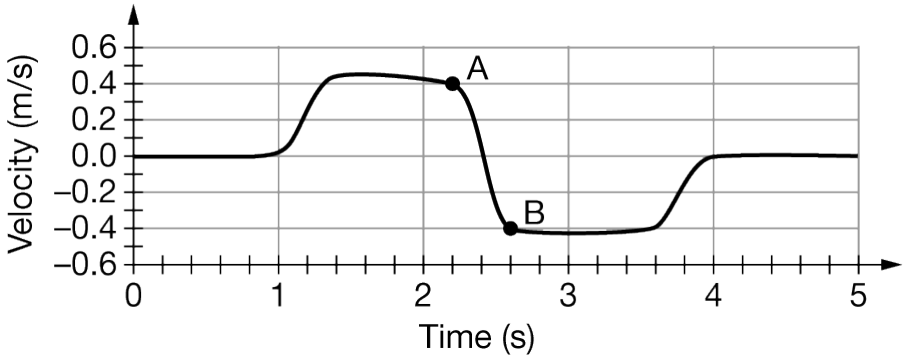
(A) The system containing block X is an open system, and the system of both blocks is an open system. ✓

(B) The system containing block X is an open system, and the system of both blocks is a closed system.

(C) The system containing block X is a closed system, and the system of both blocks is an open system.

(D) The system containing block X is a closed system, and the system of both blocks is a closed system.

5.



An experiment is conducted in which a cart travels across a horizontal surface and collides with a wall. Data collected from the experiment are used to create the graph of the cart's velocity as a function of time. All frictional forces are considered to be negligible. Which data from the graph should the student use to determine the direction of the net force exerted on the cart and the direction of the change in momentum of the cart from the time intervals of A to B?

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(A) The slope of the line from A to B, because that will provide information about the acceleration of the cart. ✓

(B) The area bound by the curve and the horizontal axis from A to B, because that will provide information about the displacement of the cart.

(C) The difference in speed of the cart from A to B, because that will provide information about how the momentum of the cart changed.

(D) The graph cannot be used to make the determination, because the mass of the cart must be known in order to apply $\Delta \vec{p} = \vec{F}\,\Delta t$.

6. During an experiment, a toy car accelerates forward for a total time of $5\ \mathrm{s}$. Which of the following procedures could a student use to determine the average net force exerted on the car during the $5\ \mathrm{s}$ that the car accelerates?

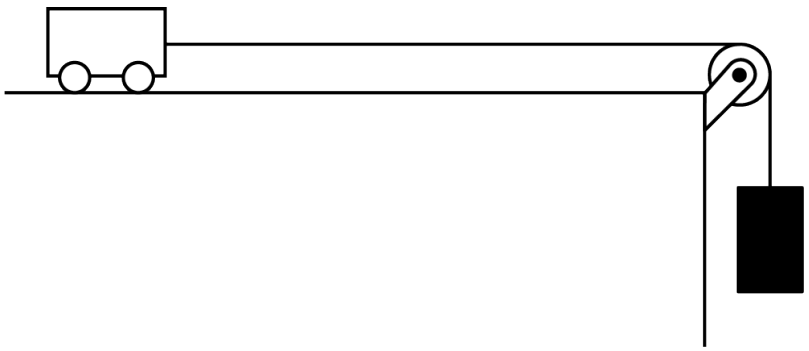
(A) Use a meterstick and stopwatch to measure the distance the car travels for the $5\ \mathrm{s}$.

(B) Use a balance to determine the mass of the car. Use a motion sensor to measure the speed of the car at a time of $0\ \mathrm{s}$ and a time of $5\ \mathrm{s}$. ✓

(C) Use a balance to determine the mass of the car. Use a meterstick to measure the distance the car travels for the $5\ \mathrm{s}$.

(D) Use a motion sensor to measure the speed of the car at a time of $0\ \mathrm{s}$ and a time of $5\ \mathrm{s}$. Use a meterstick to determine the distance the car travels for $5\ \mathrm{s}$.

7.



A cart is attached to a hanging block by a string that passes over a pulley, as shown in the figure. The pulley has negligible friction in its axle and negligible mass. A student must determine the change in momentum of the cart as it is pulled across the horizontal surface from the moment the cart is released from rest to the moment immediately before the cart collides with the pulley. Which of the following lists the measuring devices that are needed to determine the change in momentum of the cart?

(A) Timer

(B) Timer and mass balance

(C) Timer, mass balance, and meterstick ✓

(D) Timer, mass balance, meterstick, and force probe

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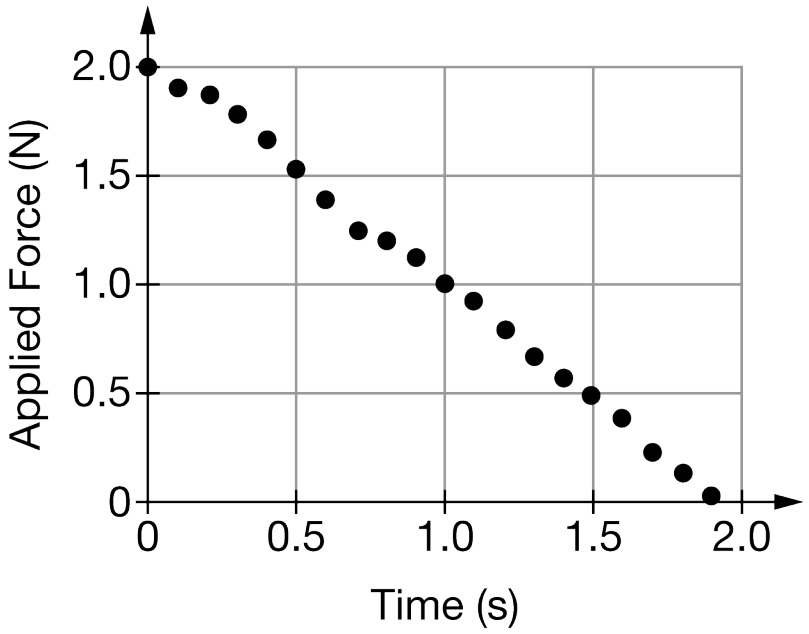
8.



A student conducts an experiment in which a cart is pulled by a variable applied force during a $2\,\text{s}$ time interval. In trial 1, the student exerts the force on a cart of mass M. In trial 2, the student exerts the force on a cart of mass $3M$. In trial 3, the student exerts the force on a cart of $5M$. In which trial will the cart experience the greatest change in momentum from $0\,\text{s}$ to $2\,\text{s}$?

(A) Trial 1

(B) Trial 2

(C) Trial 3

(D) The change in momentum is equal for all three trials from $0\,\text{s}$ to $2\,\text{s}$. ✓

9. A toy car of mass $2\ \text{kg}$ travels along a horizontal surface with negligible friction at a speed of $1.0\ \frac{\text{m}}{\text{s}}$. The car then collides with a vertical wall. The wall applies a force of magnitude $20\ \text{N}$ for $0.2\ \text{s}$ on the toy car. Which of the following predicts the motion of the toy car immediately after the collision?

(A) The speed of the car will increase, and the car will travel in the opposite direction.

(B) The speed of the car will decrease, and the car will travel in the opposite direction.

(C) The speed of the car will remain the same, and the car will travel in the opposite direction. ✓

(D) The car will stop and remain motionless.

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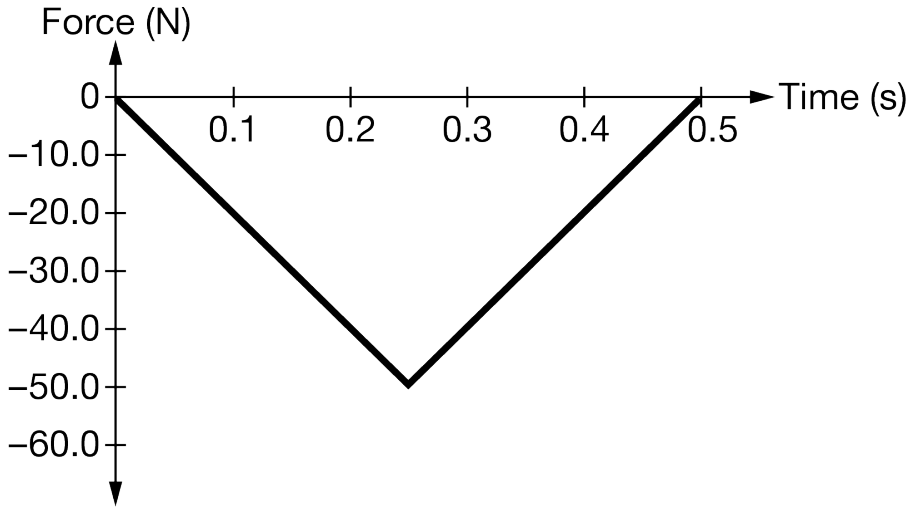
10.



A block of mass of $10\ \text{kg}$ travels in the positive direction along a surface with negligible friction. The block has an initial momentum $18\ \frac{\text{kg·m}}{\text{s}}$. The block collides with an object of an unknown mass that is at rest. The force exerted on the block as a function of time is shown on the graph. Which of the following best predicts the speed and direction of the block immediately after the collision?

(A)

Speed	Direction
Increases	Same Direction

(B) ✓

Speed	Direction
Decreases	Same Direction

(C)

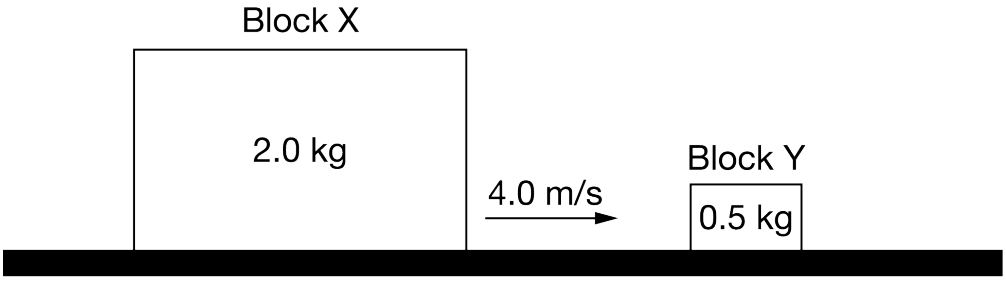
Speed	Direction
Increases	Opposite Direction

(D)

Speed	Direction
Decreases	Opposite Direction

Unit 5 Progress Check: MCQ Part A

11.



Note: Velocity vectors are not drawn to scale.

Block X travels towards Block Y that is initially at rest, as shown in the figure, and eventually collides with Block Y. Which of the following diagrams represents the final velocities for Block X and Block Y after the collision if the collision is elastic?

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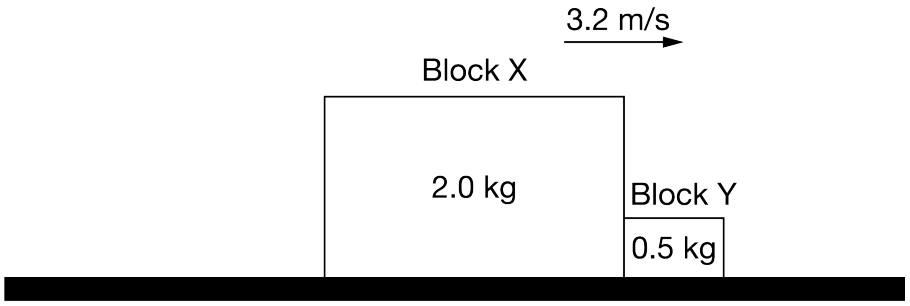
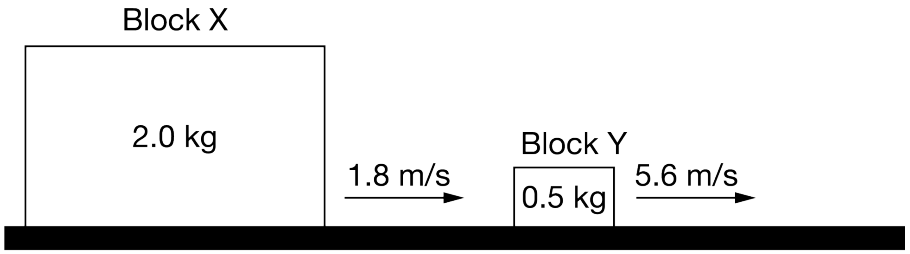
(A)



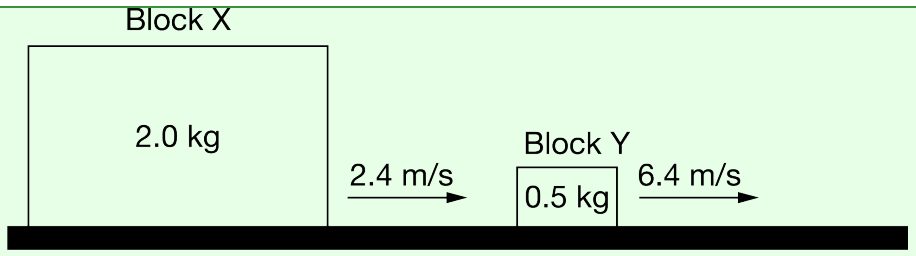
Note: Velocity vectors are not drawn to scale.

(B)



Note: Velocity vectors are not drawn to scale.

(C) ✓



Note: Velocity vectors are not drawn to scale.

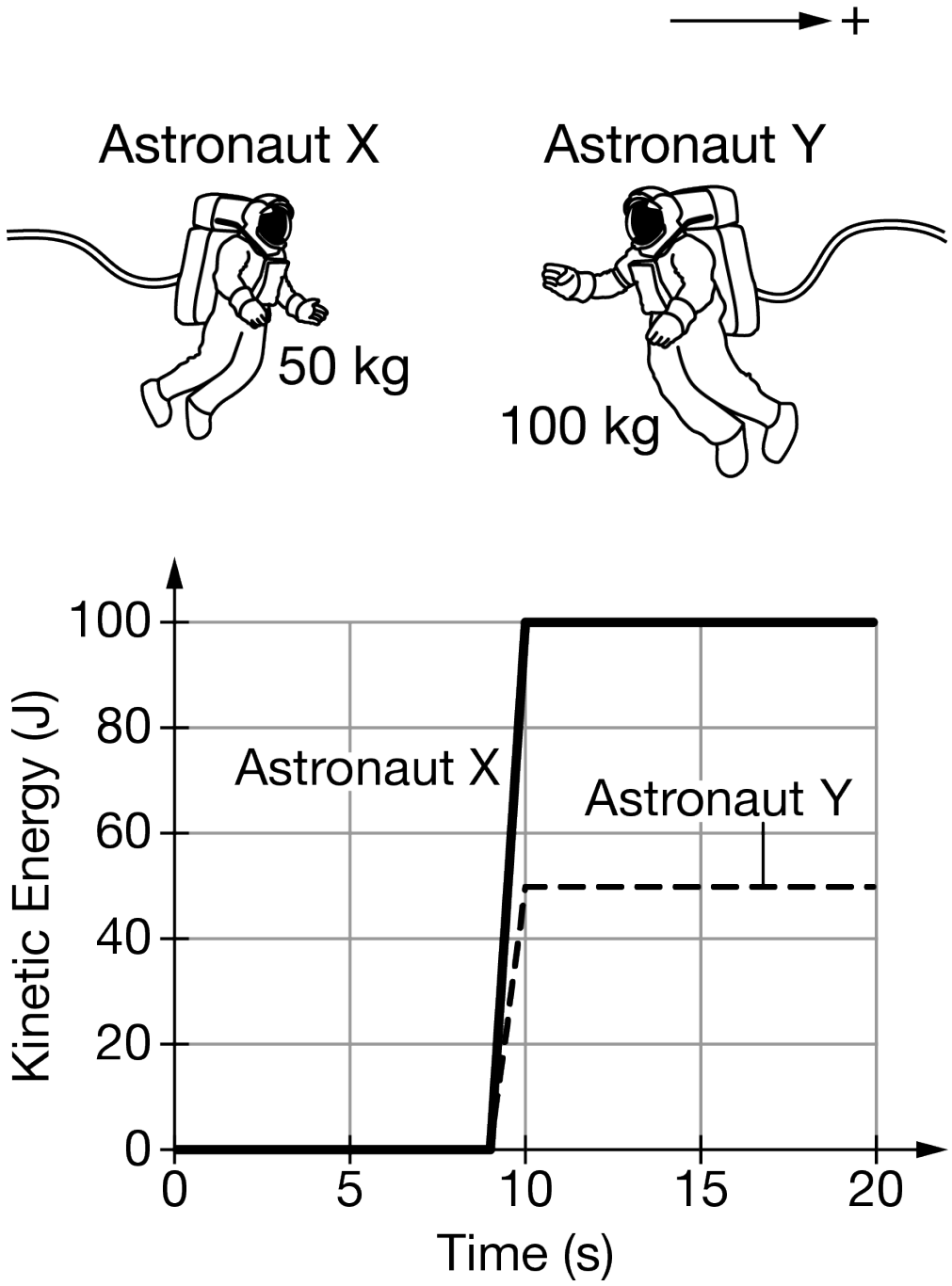
(D)



Note: Velocity vectors are not drawn to scale.

Unit 5 Progress Check: MCQ Part A

12.



Astronaut X of mass 50 kg floats next to Astronaut Y of mass 100 kg while in space, as shown in the figure. The positive direction is shown. Astronaut X applies a force against Astronaut Y such that the kinetic energy of each astronaut as a function of time is shown in the graph. What is the change in momentum of the two-astronaut system and the change in momentum of each astronaut from immediately before the force was applied to immediately after the force was applied?

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(A)

Change in Momentum of the System $(\text{kg} \cdot \text{m/s})$	Change in Momentum of Astronaut X $(\text{kg} \cdot \text{m/s})$	Change in Momentum of Astronaut Y $(\text{kg} \cdot \text{m/s})$
0	0	0

(B)

Change in Momentum of the System $(\text{kg} \cdot \text{m/s})$	Change in Momentum of Astronaut X $(\text{kg} \cdot \text{m/s})$	Change in Momentum of Astronaut Y $(\text{kg} \cdot \text{m/s})$
50	-100	50

(C) ✓

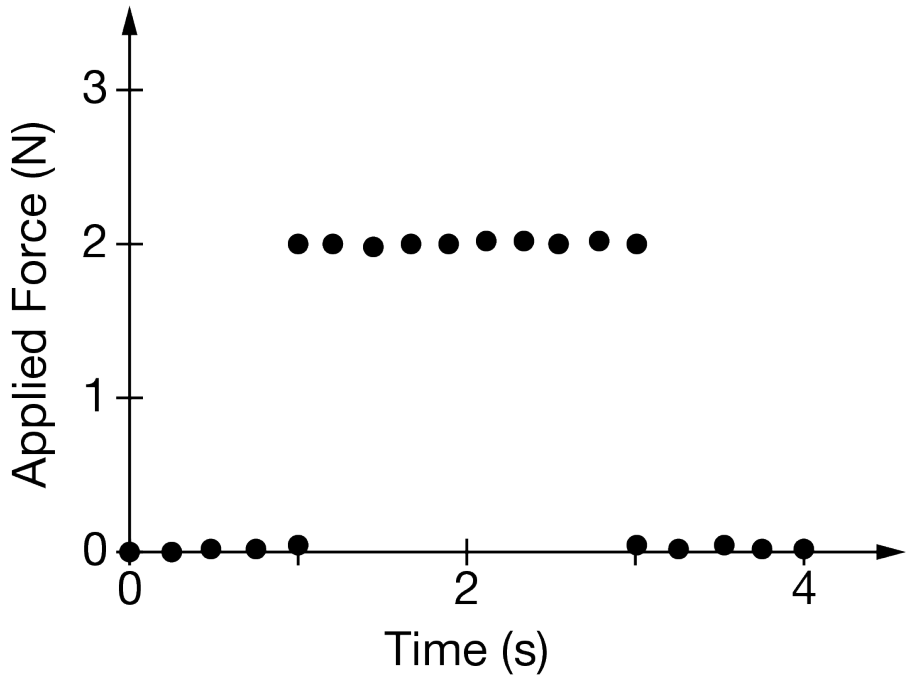
Change in Momentum of the System $(\text{kg} \cdot \text{m/s})$	Change in Momentum of Astronaut X $(\text{kg} \cdot \text{m/s})$	Change in Momentum of Astronaut Y $(\text{kg} \cdot \text{m/s})$
0	-100	100

(D)

Change in Momentum of the System $(\text{kg} \cdot \text{m/s})$	Change in Momentum of Astronaut X $(\text{kg} \cdot \text{m/s})$	Change in Momentum of Astronaut Y $(\text{kg} \cdot \text{m/s})$
200	-100	50

Unit 5 Progress Check: MCQ Part A

13.



A force is applied to a $2\ \text{kg}$ object, and measurements of the force as a function of time are shown. The force is the only force exerted on the object and is applied in the direction of the object's velocity. Which of the following could represent the initial velocity, v_0, and the final velocity, v_f, of the object?

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(A)

v_0	v_f
$4\,\mathrm{m/s}$	$6\,\mathrm{m/s}$

(B)

v_0	v_f
$6\,\mathrm{m/s}$	$4\,\mathrm{m/s}$

(C)

v_0	v_f
$2\,\mathrm{m/s}$	$6\,\mathrm{m/s}$

(D)

v_0	v_f
$6\,\mathrm{m/s}$	$2\,\mathrm{m/s}$

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14.

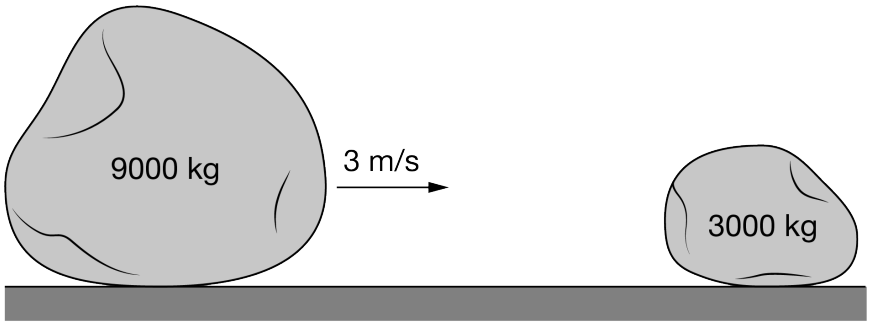


Figure 1. Before the collision

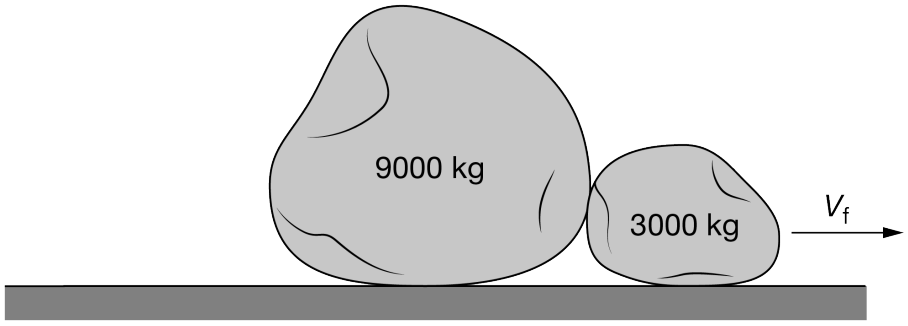


Figure 2. After the collision

A $9000\ \text{kg}$ rock slides on a horizontal surface with negligible friction at $3\ \text{m/s}$ toward a $3000\ \text{kg}$ rock that is at rest, as shown in Figure 1. A collision occurs such that the two rocks remain stuck together and travel with a common final speed v_f , as shown in Figure 2. What is the speed v_f of the two-object system after the collision?

(A) $0.0\ \text{m/s}$

(B) $1.5\ \text{m/s}$

(C) $2.25\ \text{m/s}$ ✓

(D) $3.0\ \text{m/s}$

15.

Experiment	Initial Velocity of Cart X (m/s)	Initial Velocity of Cart Y (m/s)	Final Velocity of Cart X (m/s)	Final Velocity of Cart Y (m/s)
1	1	0	0	1
2	1	−1	−1	1
3	2	1	1	2

A student performs several experiments in which two carts collide as they travel along a horizontal surface. Cart X and Cart Y both have a mass of $1\ \text{kg}$. Data collected from the three experiments are shown in the table. During which experiment does the center of mass of the system of two carts have the greatest change in its momentum?

Unit 5 Progress Check: MCQ Part A

(A) Experiment 1

(B) Experiment 2

(C) Experiment 3

(D) All experiments have the same change in momentum for the center of mass of the system of two carts. ✓

16.

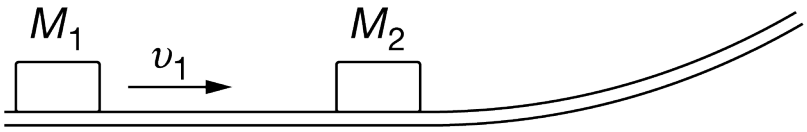


Figure 1

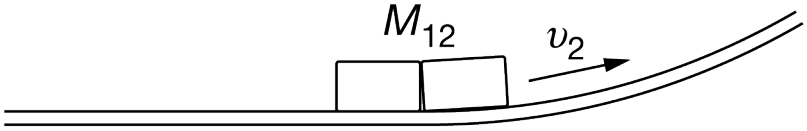


Figure 2

A mass M_1 slides along a horizontal surface and collides with and sticks to a mass M_2 that is initially at rest at the bottom of a ramp, as shown in Figure 1. Frictional forces between the masses, the surface, and the ramp are considered to be negligible. After the collision, masses M_1 and M_2 slide together up the curved ramp as a total mass of M_{12} , as shown in Figure 2. The two masses eventually come to rest at their highest position along the ramp. Which of the following claims is correct regarding the momentum of the system of mass M_1 and the system of mass M_1 and M_2 in terms of their momenta?

(A) The system of mass M_1 is an open system, and the system of mass M_1 and M_2 is an open system. ✓

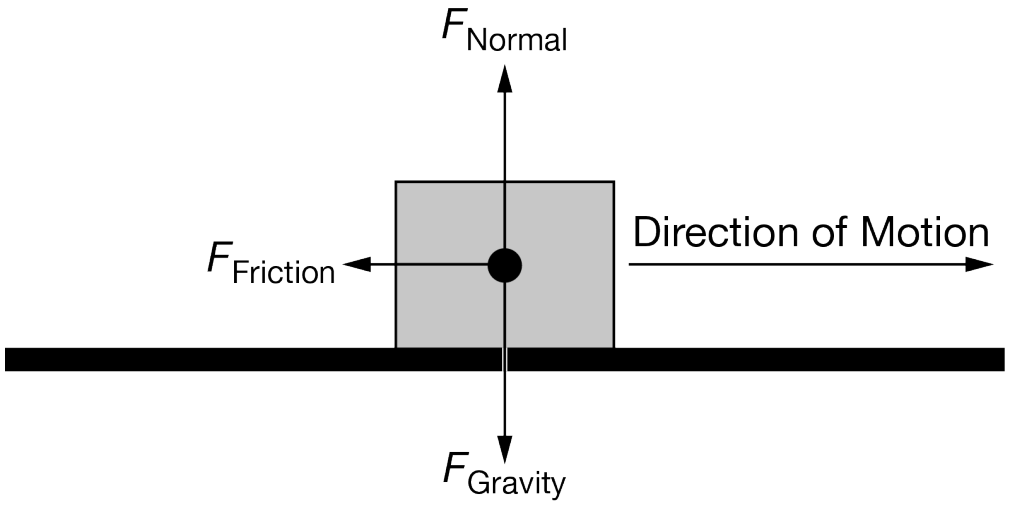
(B) The system of mass M_1 is an open system, and the system of mass M_1 and M_2 is a closed system.

(C) The system of mass M_1 is a closed system, and the system of mass M_1 and M_2 is an open system.

(D) The system of mass M_1 is a closed system, and the system of mass M_1 and M_2 is a closed system.

Unit 5 Progress Check: MCQ Part A

17.



A block travels across a horizontal surface in which frictional forces are not considered to be negligible, as shown in the figure. Which of the following quantities should a student measure to verify that the direction of the frictional force exerted on the block from the surface is in the same direction as the change in momentum of the block? Select two answers. Justify your selections.

A. The coefficient of friction between the block and the surface, because the force of friction is proportional to the coefficient of friction.

B. The mass of the block, because the force of friction is proportional to the mass of the block.

C. The initial velocity, because the initial momentum of the block is proportional to the final momentum of the block. ✓

D. The final velocity, because the initial momentum of the block is proportional to the final momentum of the block. ✓