Unit 5 Progress Check: MCQ Part B

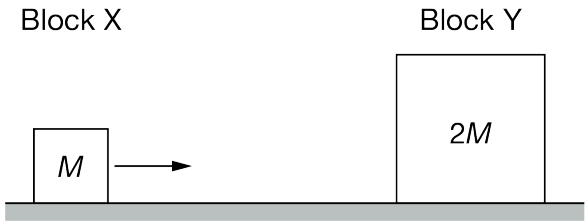

Figure 1. Before the collision

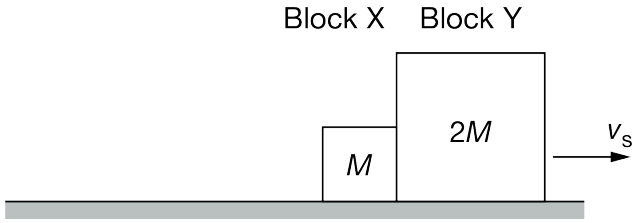

Figure 2. After the collision

Block X of mass M slides across a horizontal surface where friction is negligible. Block X collides with block Y of mass $2M$ that is initially at rest, as shown in Figure 1. After the collision, both blocks slide together with a speed v_s , as shown in Figure 2.

1. What is the kinetic energy of the two-block system before the collision?

(A) $\frac{1}{2}Mv_s^2$

(B) $\frac{3}{2}Mv_s^2$

(C) $\frac{9}{2}Mv_s^2$ ✓

(D) $\frac{27}{2}Mv_s^2$

2. What is the speed of the center of mass of the two-block system immediately before the collision?

(A) The speed is $\frac{v_s}{3}$.

(B) The speed is v_s. ✓

(C) The speed is $\frac{3v_s}{2}$.

(D) The speed is $3v_s$.

3. How could a student verify that the collision under consideration is an inelastic collision for the two-block system?

(A) By comparing the final momentum of the system with the initial momentum of the system

(B) By comparing the final kinetic energy of the system with the initial kinetic energy of the system ✓

(C) By comparing the final velocity of the center of mass of the system with the initial velocity of the center of mass of the system

(D) By comparing the final velocity of block Y with the initial velocity of block Y

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4. Block X of mass M travels with a speed v_0. Block Y of mass $2M$ travels with a speed $2v_0$. Both blocks travel toward each other and collide. After the blocks collide, they separate so that the kinetic energy of the system remains conserved. Which of the following equations for the conservation of momentum could a student use to help determine the speed v_f of each block after the collision?

(A) $m_0v_0 - 4m_0v_0 = m_0v_{Xf} + 2m_0v_{Yf}$, because the two blocks initially travel in opposite directions, and the blocks do not stick after the collision. ✓

(B) $m_0v_0 + 4m_0v_0 = m_0v_{Xf} + 2m_0v_{Yf}$, because the two blocks initially travel toward each other, and the blocks do not stick after the collision.

(C) $m_0v_0 - 4m_0v_0 = 3m_0v_{system\,f}$, because the two blocks initially travel in opposite directions, and the velocity of the center of mass should first be determined.

(D) $m_0v_0 + 4m_0v_0 = 3m_0v_{system\,f}$, because the two blocks initially travel toward each other, and the velocity of the center of mass should first be determined.

5. Block X and block Y travel toward each other along a horizontal surface with block X traveling in the positive direction. Block X has a mass of $4\ \mathrm{kg}$ and a speed of $2\ \frac{\mathrm{m}}{\mathrm{s}}$. Block Y has a mass of $1\ \mathrm{kg}$ and a speed of $1\ \frac{\mathrm{m}}{\mathrm{s}}$. A completely inelastic collision occurs in which momentum is conserved. What is the approximate speed of block X after the collision?

(A) $0.3\ \frac{\mathrm{m}}{\mathrm{s}}$

(B) $1.4\ \frac{\mathrm{m}}{\mathrm{s}}$ ✓

(C) $1.8\ \frac{\mathrm{m}}{\mathrm{s}}$

(D) The speed of block X after the collision cannot be determined without knowing the speed of block Y after the collision.

6. Block X and block Y travel toward each other along a horizontal surface with block X traveling in the positive direction. Block X has a mass of $2\ \mathrm{kg}$ and a speed of $3\ \mathrm{m/s}$. Block Y has a mass of $1\ \mathrm{kg}$ and a speed of $3\ \mathrm{m/s}$. After the collision, block X travels in the horizontal direction with a speed of $1\ \mathrm{m/s}$ in the negative direction. What is the speed of block Y if the collision is elastic?

(A) $1\ \mathrm{m/s}$

(B) $5\ \mathrm{m/s}$ ✓

(C) $7\ \mathrm{m/s}$

(D) $11\ \mathrm{m/s}$

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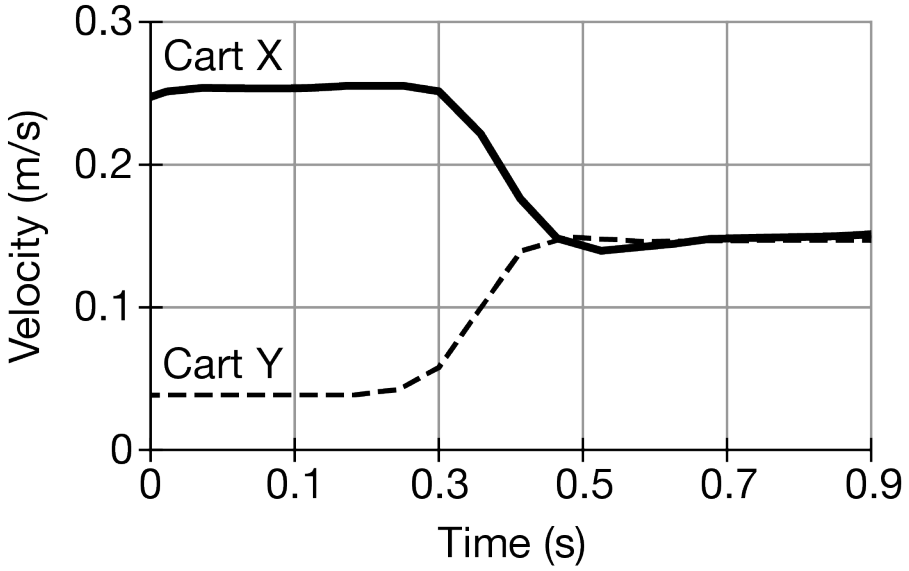
7.



Cart X travels in the positive direction along a horizontal surface, and cart Y travels in the positive direction. The carts collide, and a student collects data about the carts' velocities as a function of time before, during, and after a collision, as shown. The masses of both objects are known. Which of the following best indicates how the student should use the graph to determine whether the collision is elastic or inelastic and provides a correct justification?

(A) Using the known mass and known velocity for each cart to determine the kinetic energy of the system before and after the collision, because the kinetic energy changes in an inelastic collision ✓

(B) Using the known mass and known velocity for each cart to determine the momentum before and after the collision, because the momentum changes in an inelastic collision

(C) Using the known mass and known velocity for each cart to determine the change in momentum for each object before and after the collision, because the momentum changes in an elastic collision

(D) Using the known mass and known velocity for each cart to determine the average force exerted on each object before and after the collision, because the forces exerted on the objects have different magnitudes in an inelastic collision

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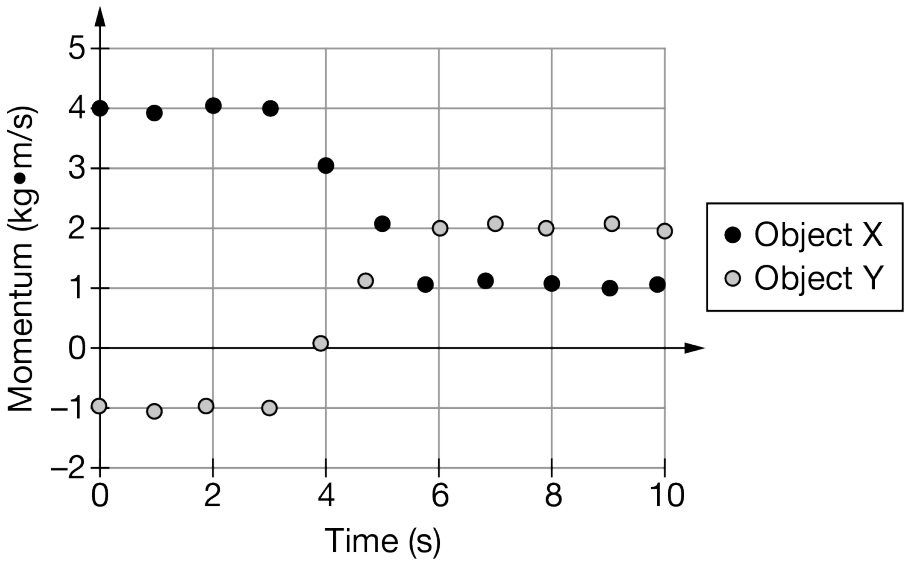
8.



In an experiment, two objects, Object X and Object Y, travel toward each other and collide. Data are collected about each object before, during, and after the collision to create a graph that shows the momenta of Object X and Object Y as a function of time. How should a student use the data found on the graph to verify the conservation of momentum?

(A) The sum of the magnitudes of the momenta should be compared, because momentum is a scalar quantity.

(B) The vector sum of the momenta should be compared, because momentum is a vector quantity. ✓

(C) Data from the graph cannot be used, because a graph of the velocities of Object X and Object Y should have been created.

(D) Data from the graph cannot be used, because a graph of the force exerted on Object X by Object Y as a function of time and a graph of the force exerted on Object Y by Object X as a function of time should have been created.

9.



A student must conduct an experiment to verify the conservation of momentum. Cart X and Cart Y travel toward each other and eventually collide, as shown in the figure. The student has access to the two carts, one mass balance, and two motion detectors. If the mass of each cart is known, how should the student arrange one or both motion detectors so that the student can collect enough information about the motion of the carts, in order to verify the conservation of momentum of the system?

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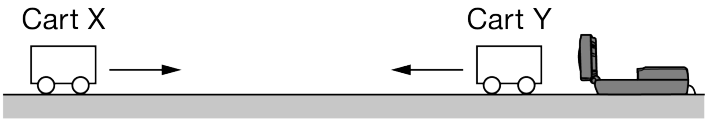
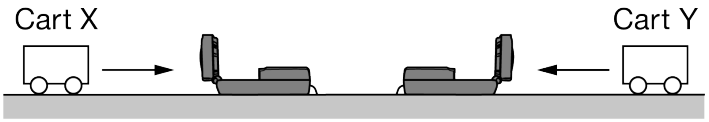
(A)



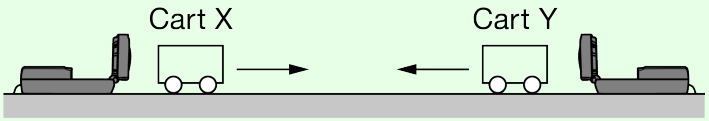
(B)



(C)



(D) ✓



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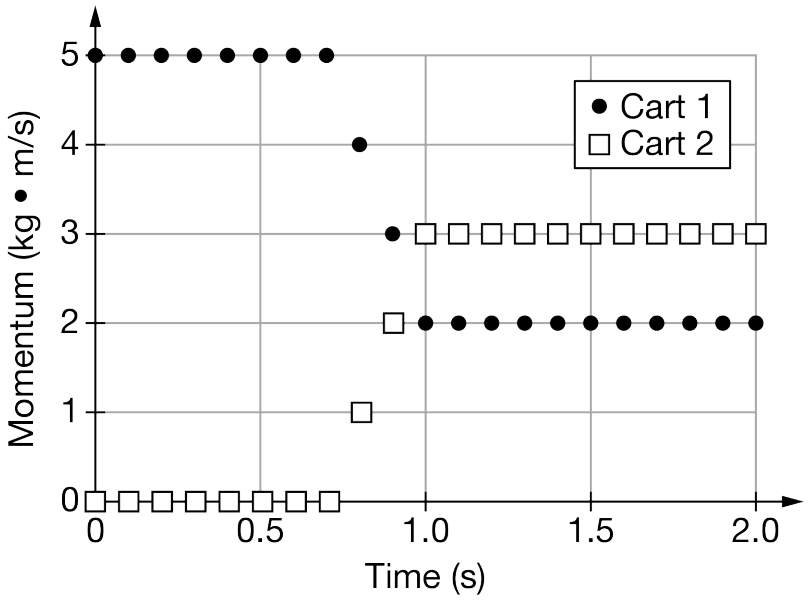
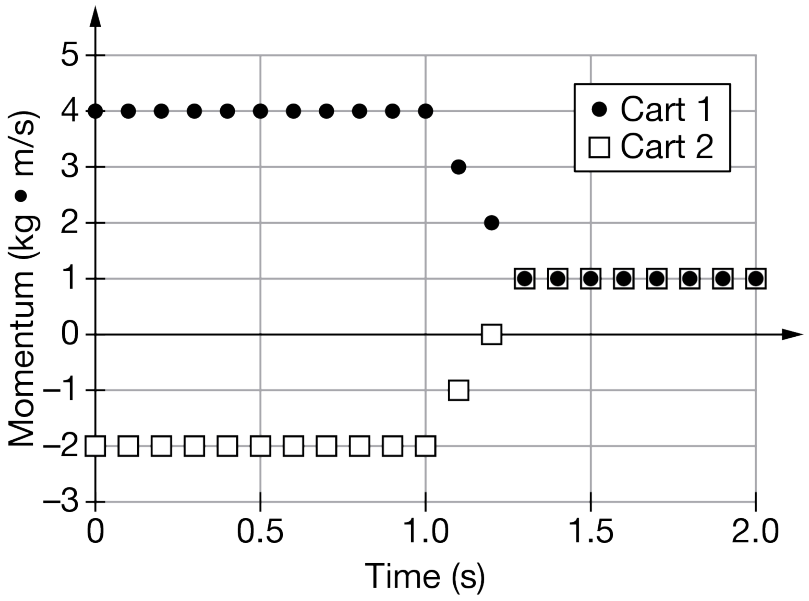
10.



Experiment 1



Experiment 2

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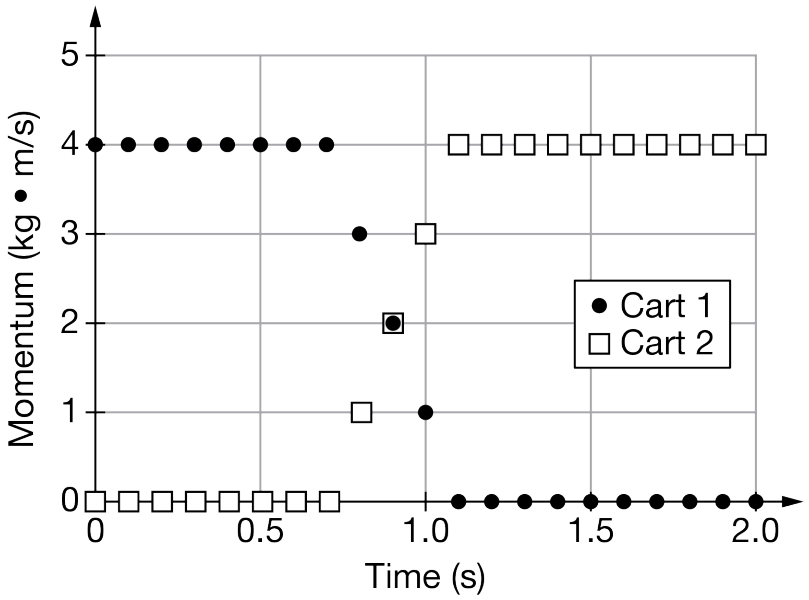

Experiment 3

A student conducts three experiments in which two carts, cart 1 and cart 2, travel toward each other and collide. A graph of each cart's momentum as a function of time is shown above. In which experiment, if any, does the graph indicate the presence of a net external force exerted on the two-cart system?

(A) Experiment 1

(B) Experiment 2

(C) Experiment 3

(D) None of the experiments indicate the presence of a net external force. ✓

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11.

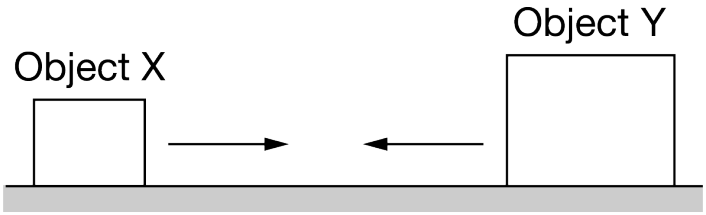

Figure 1. Before the Collision

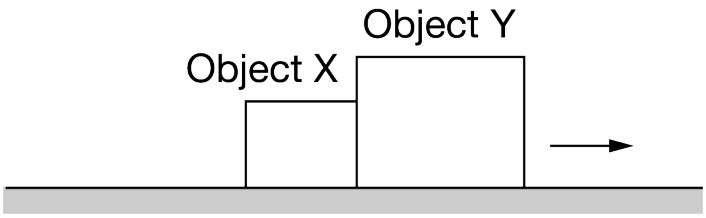

Figure 2. After the Collision

Trial Number	Mass of Object $\mathrm{X}(\mathrm{kg})$	Mass of Object $\mathrm{Y}(\mathrm{kg})$	Speed of Object X before Collision $(\mathrm{m/s})$	Speed of Object Y before Collision $(\mathrm{m/s})$	Speed of the System after Collision $(\mathrm{m/s})$
1	2.1 ± 0.1	1.0 ± 0.1	2.1 ± 0.1	1.1 ± 0.1	1.1 ± 0.1
2	1.9 ± 0.1	1.1 ± 0.1	2.0 ± 0.1	1.0 ± 0.1	0.9 ± 0.1
3	2.0 ± 0.1	0.9 ± 0.1	2.1 ± 0.1	1.0 ± 0.1	1.1 ± 0.1

A student conducts an experiment to verify whether momentum is conserved for a situation in which a collision occurs. The two objects, Object X and Object Y, travel toward each other, as shown in Figure 1. After the collision, the two objects travel as shown in Figure 2. Data collected from three trials of this experiment are shown in the table. Which of the following statements is correct based on the data?

(A) The conservation of momentum can be verified within the threshold of experimental uncertainty. ✓

(B) The conservation of momentum cannot be verified within the threshold of experimental uncertainty.

(C) The conservation of momentum can be verified within the threshold of experimental uncertainty for Trials 1 and 2 but cannot be verified within the threshold of experimental uncertainty for Trial 3.

(D) It cannot be determined whether the conservation of momentum can be verified because the experimental uncertainty suggests that the data cannot be analyzed without more precise measurements.

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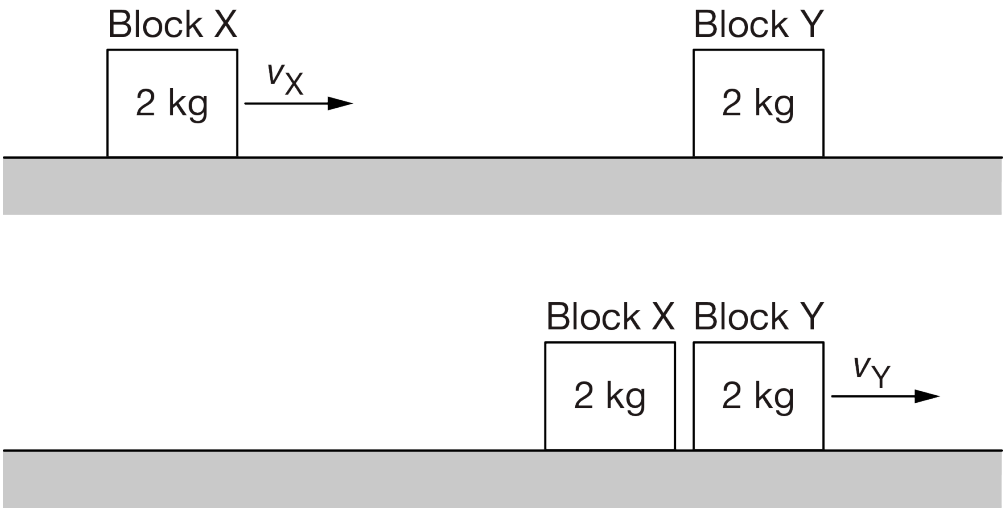
12.



Trial	Velocity of Block X Before Collision v_X $(\mathrm{m/s})$	Velocity of Block Y Before Collision $(\mathrm{m/s})$	Velocity of Block X After Collision $(\mathrm{m/s})$	Velocity of Block Y After Collision v_Y $(\mathrm{m/s})$
1	3.1	0.0	0.1	2.4
2	5.2	0.0	-0.1	4.4
3	2.1	0.0	0.0	1.5

A student must conduct an experiment in which an elastic collision occurs. In the experiment, Block X of mass $2\ \mathrm{kg}$ travels with a velocity v_X in the positive direction toward Block Y of mass $2\ \mathrm{kg}$ that is at rest, as shown in Figure 1. After the collision, Block Y travels in the positive direction with velocity v_Y while Block X remains nearly at rest. Data collected of the initial and final velocities of both blocks for three trials of the experiment are shown in the table. Did the student conduct an experiment in which an elastic collision occurred? Is the system of Block X and Block Y open or closed?

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(A)

Is Collision Elastic?	Is System Open or Closed?
Yes	Open

(B)

Is Collision Elastic?	Is System Open or Closed?
Yes	Closed

(C) ✓

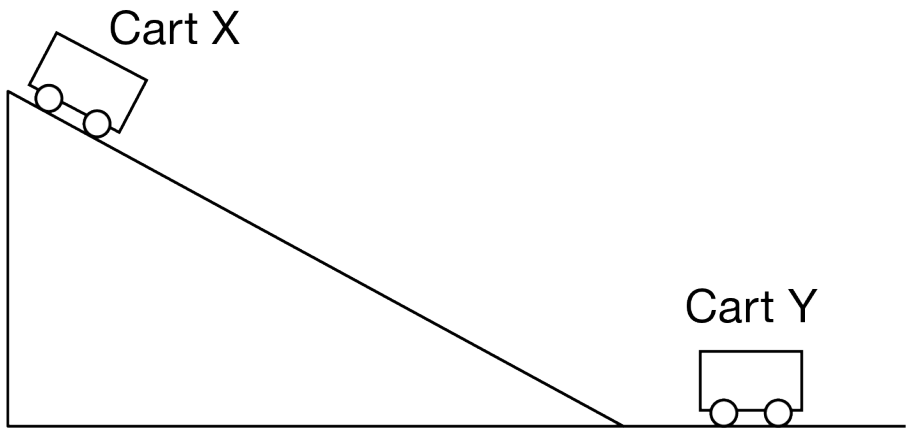
Is Collision Elastic?	Is System Open or Closed?
No	Open

(D)

Is Collision Elastic?	Is System Open or Closed?
No	Closed

Unit 5 Progress Check: MCQ Part B

13.



Note: Data for Cart X are from before the collision.

t (s)	d (m)
0.0	0.0
0.5	0.5
1.0	2.0
1.5	4.5
2.0	8.0

Cart X with a mass of $1\ \mathrm{kg}$ is released from rest at the top of an inclined ramp, and the cart rolls down the ramp with negligible friction. At the bottom of the ramp, cart X collides with cart Y, which is initially at rest. The collision is completely inelastic, and both cart X and cart Y have equal masses. Before and after the collision, data are collected about the distance d each cart travels as a function of time t. The table shows data about cart X before the collision as it travels down the ramp. Which of the following sets of data could represent the collision for cart X and cart Y?

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(A)

	Cart X	Cart Y
t (s)	d (m)	d (m)
2.5	12.0	0.1
3.0	13.0	1.1
3.5	15.0	2.1
4.0	18.0	3.1

(B)

	Cart X	Cart Y
t (s)	d (m)	d (m)
2.5	12.0	0.1
3.0	12.0	2.1
3.5	12.0	3.1
4.0	12.0	4.1

(C) ✓

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	Cart X	Cart Y
t (s)	d (m)	d (m)
2.5	12.0	0.1
3.0	14.0	2.1
3.5	16.0	4.1
4.0	18.0	6.1

(D)

	Cart X	Cart Y
t (s)	d (m)	d (m)
2.5	12.0	0.1
3.0	12.0	4.1
3.5	12.0	8.1
4.0	12.0	12.1

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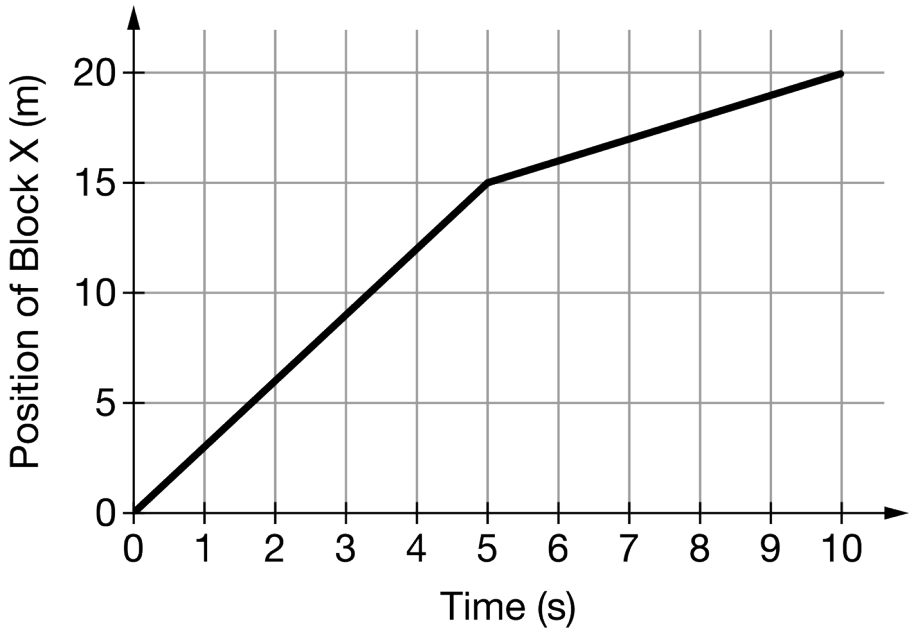
14.



Block X of mass $2\ \mathrm{kg}$ travels across a horizontal surface toward block Y of unknown mass that is initially at rest. Block X then collides elastically with block Y. A graph of the position as a function of time for block X is shown. Block X and block Y are made of the same material. Which of the following predictions is correct about the motion of block Y immediately after the collision?

(A) The acceleration of block Y immediately after the collision is greater than the acceleration of block Y immediately before the collision.

(B) The kinetic energy of block Y immediately after the collision is greater than the kinetic energy of block X immediately after the collision. ✓

(C) The magnitude of the change in momentum of block Y from immediately before the collision to immediately after the collision is more than the magnitude of the change in momentum of block X .

(D) The momentum of the system consisting of block X and block Y immediately after the collision is less than the momentum of the system immediately before the collision.

15. A constant force F_A is applied to an object of mass M, initially at rest. The object moves in the horizontal x -direction, and the force is applied in the same direction. After the force has been applied, the object has a speed of v_{f}. Which mathematical routines can be used to determine the time in which the force is applied to the object of mass M? Select two answers.

A $\Delta t = \frac{\Delta p_x}{F_A}$ ✓

B $\Delta t = \frac{M v_f}{F_A}$ ✓

C $\Delta t = \frac{(\Delta M) v_f}{F_A}$

D $\Delta t = \frac{M v_f}{\Delta F_A}$

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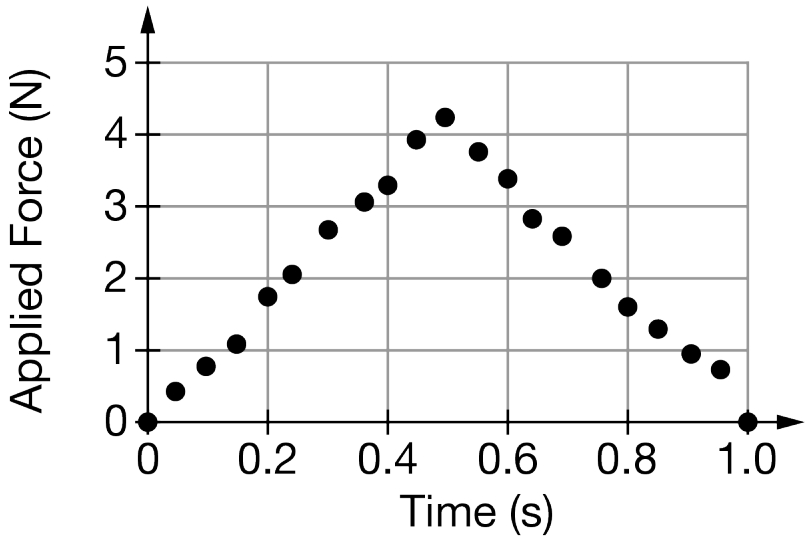
16.



An object travels in the positive direction with a momentum of $5\ \frac{\text{kg·m}}{\text{s}}$. An applied force is exerted on the object, and a graph of the magnitude of the applied force as a function of time is shown. All frictional forces are considered to be negligible. Which of the following could represent the approximate momentum of the object after the force has been applied? Select two answers.

A $0\ \frac{\text{kg·m}}{\text{s}}$

B $3\ \frac{\text{kg·m}}{\text{s}}$ ✓

C $5\ \frac{\text{kg·m}}{\text{s}}$

D $7\ \frac{\text{kg·m}}{\text{s}}$ ✓

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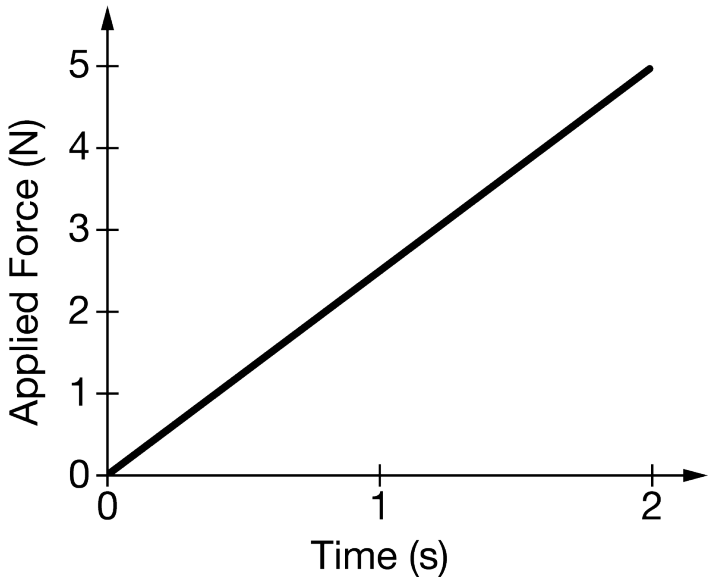
17.



A variable applied force is exerted on a $2\ \text{kg}$ block as it travels across a horizontal surface for a time of $2\ \text{s}$, as shown in the graph. Before the force is applied to the block, it travels with a speed of $1\ \frac{\text{m}}{\text{s}}$. The force is exerted on the block in the same direction as the block's displacement while the force is exerted. After the force is applied to the block, the block travels with a speed of $5\ \frac{\text{m}}{\text{s}}$. Which of the following statements are correct regarding the motion of the block? Select two answers.

A The block travels a distance of $4.5\ \text{m}$.

B There must be another force exerted on the block during the time in which the applied force is exerted. ✓

C The change in momentum of the block from the applied force is $5\ \frac{\text{kg}\cdot\text{m}}{\text{s}}$. ✓

D The momentum of the system containing the block is conserved.

18. A student must perform an experiment in which two objects travel toward each other and collide so that the data collected can be used to show that the collision is elastic within the acceptable range of experimental uncertainty. Which of the following measuring tools, when used together, can the student use to verify that the collision is elastic? Select two answers.

A A motion detector ✓

B A meterstick

C A balance ✓

D A stopwatch