**CONSERVATION OF MOMENTUM**

DO NOW: DIAGRAMMING AND CALCULATING MOMENTUM

***Directions:*** *Answer the questions below in using notes or from memory:*

1. The student below has drawn a motion diagram for a car before and after it slows down. Assuming the car slowed down by 10m/s, find two mistakes in their diagrams:



1500 kg

 -10m/s

1500kg

+20m/s

Mistake 1:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mistake 2:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. In the diagram, make the changes you wrote above, to create a correct diagram.
2. Calculate the momentum of the car before it slows down. Show all work.

EXPLORE: RELATIONSHIPS FOR MOMENTUM IN COLLISIONS

***Guided Practice:*** *As your teacher explains how to solve the following problems, you should be following along by listening, watching, and writing.*

The diagrams below appeared on your homework. They are posted again below, with work.

 **Before After**



110 kg

110 kg

+12m/s

+14m/s

 -4m/s

88 kg

 -6m/s

88 kg

1. Calculate the momentum of each player before the collision:

PLAYER 1: PLAYER 2:

1. Calculate the momentum of each player after the collision:

PLAYER 1: PLAYER 2:

1. Add the momentum of the 2 players before the collision to find their total momentum before:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Add the momentum of the 2 players after the collision, to find their total momentum after:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What do you notice about the total momentum of the players in this collision\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Hypothesis:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***Directions:*** *On the following two pages, you will find 3 additional scenarios. A description of each is detailed below. With your group members, divide up the work and calculate the before and after momentums in each scenario, in order to prove or revise your hypothesis*

**Example Scenario:** A heavy cart traveling to the right collides with a light cart traveling to the left and the two bounce apart.

**Scenario 1:** A moving heavy cart collides with a stationary light cart, and the two bounce apart.

**Scenario 2:** Two carts of equal mass are traveling the same direction. The faster cart collides with the slower cart and they stick together

**Scenario 3:** A heavy cart traveling slow to the right collides with a light cart traveling fast to the left and the two stick together.

**Scenario 1:** A moving heavy cart collides with a stationary light cart, and the two bounce apart.

 **Before After**



 1m/s

4 kg

8 kg

4 kg

8 kg

+3m/s

+4m/s

1. Calculate the momentum of each cart before the collision:

CART 1: CART 2:

1. Calculate the momentum of each cart after the collision:

CART 1: CART 2:

1. Add the momentum of the 2 carts before the collision to find their total momentum before:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Add the momentum of the 2 carts after the collision, to find their total momentum after:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Scenario 2:** Two carts of equal mass are traveling the same direction. The faster cart collides with the slower cart and they stick together

 **Before After**



12 kg

+7m/s

6 kg

 +2m/s

6 kg

+12m/s

1. Calculate the momentum of each cart before the collision:

CART 1: CART 2:

1. Calculate the momentum of the two carts combined after the collision:

COMBINED CART 1+2:

1. Add the momentum of the 2 carts before the collision to find their total momentum before:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Give the momentum of the 2 carts after the collision, to find their total momentum after:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Scenario 3:** A heavy cart traveling slow to the right collides with a light cart traveling fast to the left and the two stick together.

 **Before After**



6 kg

2 kg

4 kg

+2m/s

 -2m/s

 -10m/s

1. Calculate the momentum of each cart before the collision:

CART 1: CART 2:

1. Calculate the momentum of the two carts combined after the collision:

COMBINED CART 1+2:

1. Add the momentum of the 2 cart before the collision to find their total momentum before:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Give the momentum of the 2 carts after the collision, to find their total momentum after:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cite conceptual and numerical evidence from the 4 collisions we have investigated in order to confirm or reject your hypothesis (you are given many lines to write on purpose)

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**CORE IDEA:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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PRACTICE: USING CONSERVATION OF MOMENTUM

***Guided Practice:*** *As your teacher explains how to solve the following problems, you should be following along by listening, watching, and writing.*

1. During a goal-line stand, a 75-kg fullback moving right with a speed of 8 m/s collides head-on with a 100-kg lineman moving right with a velocity of 4 m/s. The two players collide and *stick together*, moving at the same velocity after the collision. Determine the post-collision momentum of the two players.



Work:

***Independent Practice Round 1:*** *Silently and independently complete the following problems. Use your notes and the sample problems from guided practice. Be ready to share and explain your answers.*

1. A 4,000kg truck driving +28m/s collides head on with a 1,200kg car, moving -30m/s, and they stick together. Find the final momentum of the system, after the collision.



Work:

1. A physics cart with momentum +1.2kg\*m/s crashes into another cart traveling the other direction. -3kg\*m/s. After the crash, they bounce apart. Find the total momentum after the collision. *(note: this problem is harder to diagram but easier to solve)*



Work:

\*If you finish early, move on to working independently on the next page.

***Independent Practice Round 1:*** *Silently and independently complete the following problems. Use your notes and the sample problems from guided practice. Be ready to share and explain your answers.*

1. A 5-kg bowling ball traveling at 6 m/s collides with a *stationary* 1-kg bowling pin, and they bounce apart. What is the total momentum after the collision?



Work:

1. During a goal-line stand, a 90-kg fullback moving right with a speed of 3 m/s collides head-on with a 120-kg lineman moving left with a -6m/s. The two players collide and *stick together*, moving at the same velocity after the collision. Determine the post-collision momentum of the two players.



Work:

***Independent Practice Round 2:*** *Silently and independently complete the following problems. Use your notes and the sample problems from guided practice. Be ready to share and explain your answers.*

1. In a physics lab, Cart A (1.25 kg) has momentum 1.3kg\*m/s when it collides with Cart B (.5 kg), which has momentum 3.2kg\*m/s. The two carts bounce apart after the collision. If cart A has a new momentum of 3.9kg\*m/s, what is the final momentum of cart B?



Work:

1. During a goal-line stand, a 75-kg fullback moving rightward at 5 m/s collides head-on with a 100-kg lineman moving left at 2m/s. The two players collide and push apart after the collision. If the final momentum of the fullback is -225kg\*m/s, Find the momentum of the lineman after the hit.



Work:

EXIT SLIP: CONSERVATION OF MOMENTUM

***Directions:*** *Answer the questions below to the best of your ability.*

1. A 2400 kg truck traveling at 18 m/s plows into a stationary 1200 kg car. If both vehicles remain stuck together after the collision, what is their momentum?



Work:



1. Two students sit stationary on rolling chairs and push apart from each other. If their total momentum before the push was 0kgm/s, and after the push student 1 has a momentum of 160kg\*m/s, then the momentum of student 2 must be -160kg\*m/s..

In the problem above, Riley Raptor states that *since the students have equal and opposite momentums, they must also have equal and opposite velocities*. Use your knowledge of momentum to:

* Agree or disagree, and
* Explain why using conceptual or numerical evidence

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PREPWORK 7.03: CONSERVATION OF MOMENTUM

***Directions:*** *Use your notes and classwork examples if needed to complete the problems below*

1. A truck with 30,000kgm/s collides head on with a car with -23,000kgm/s. Find the total momentum of the system after the collision.



Work:

1. A 1600-kilogram car moving at 10 m/s collides with a 2100-kilogram car that is moving in the same direction at 2 m/s. What is the final momentum of the first car, if the second car has a final momentum of 9,800kg\*m/s?



Work:

1. A 5000-kg truck traveling with a velocity of +4.0 m/s collides head-on with a 1200-kg car traveling with a velocity of -12 m/s. The truck and car entangle and move together after the collision. Find their total momentum after the crash.



Work:

1. A .17kg green pool ball with momentum traveling 3m/s collides with the .25kg cue ball that has velocity of -2.4m/s, moving in the other direction. After the collision, the green ball has momentum 1.2kg\*m/s. What is the momentum of the cue ball after the collision?



Work: