Unit 4B

Conservation of Momentum

Conservation of Momentum Lab

PHYSICS IN MOTION
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In any interaction between objects in a closed and isolated system, momentum is conserved because of Newton's third law of motion. In this activity, you will be conducting a virtual laboratory experiment to determine if momentum is conserved in different kinds of interactions. The virtual lab conducted will be the PhET Collision Lab.

You can find the simulation at https://phet.colorado.edu/en/simulation/legacy/collision-lab.

Part One: Collisions That "Stick"

- Open the simulation, and make sure the Introduction tab is clicked.
- Click and drag the Elasticity scale to 0%, making the objects stick together.

Set the mass of the two objects to the same value, and click on More Data below the mass values. You should now see the position, velocity, and momentum values. Add these initial values to the data table below.

Initial Values (pre-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

After the two objects collide, again note the mass, velocity, and momentum values.
Add these final values to the data table below.

Final Values (post-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

Next, triple the mass of object 2 compared to its initial value.
Conduct the experiment again, completing the tables with values from before and after the collision.

Initial Values (pre-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

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Final Values (post-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

Questions to Consider for Part One

1. How does the total momentum of the system before and after the collision compare in each scenario?

2. Does this support the law of conservation of momentum?

3. When the two objects have equal masses, how does the final velocity of the two objects moving together compare to the initial velocity of object 1?

4. What is the change in velocity of object 1 when the masses are equal? What does the sign of this change indicate about the direction of the force on object 1? Draw a free-body diagram of the forces acting on object 1.

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Questions to Consider for Part One

5. What is the change in velocity of object 2 when the masses are equal? What does the sign of this change indicate about the direction of the force on object 2? Draw a free-body diagram of the forces acting on object 2.

6. Do the directions of the forces acting on object 1 and object 2 support your understanding of why momentum is conserved? Explain.

7. When the mass of the object initially at rest (object 2) is tripled, how does the velocity of object 1 before the collision compare to the velocity of the two objects after the collision?

8. Do the two objects experience an equal change in velocity when their masses are unequal? If not, which object experiences a greater change in velocity?

9. If an object has more mass but experiences a smaller change in velocity than a second object, how does the force the more massive object experiences compare to the force on the less massive object?

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Part Two: Collisions That "Bounce"

- Open the simulation, and make sure the Introduction tab is clicked.
- Click and drag the Elasticity scale to 100%, making the objects bounce off one another.

Set the mass of the two objects to the same value, and click on More Data below the mass values. You should now see the position, velocity, and momentum values. Add these initial values to the data table below.

Initial Values (pre-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

After the two objects collide, again note the mass, velocity, and momentum values.
Add these final values to the data table below.

Final Values (post-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

Next, triple the mass of object 2 compared to its initial value.
Conduct the experiment again, completing the tables with values from before and after the collision.

Initial Values (pre-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

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Final Values (post-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

Finally, change the mass of object 1 to back to its original value, and set the mass of object 2 to a value three times what it was previously. Conduct the experiment again, and fill in the data tables with values before and after the collision.

Initial Values (pre-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

Final Values (post-collision)

Object	Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
1			
2			
TOTAL			

Questions to Consider for Part Two

1. How does the total momentum of the system compare in each scenario?

2. Does this support the law of conservation of momentum?

3. When the two objects have equal masses, how does the final velocity of object 2 compare to the initial velocity of object 1?

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Questions to Consider for Part Two

4. What is the change in velocity of object 1 when the masses are equal? What does the sign of this change indicate about the direction of the force on object 1? Draw a free-body diagram of the forces acting on object 1.

5. What is the change in velocity of object 2 when the masses are equal? What does the sign of this change indicate about the direction of the force on object 2? Draw a free-body diagram of the forces acting on object 2.

6. Do the directions of the forces acting on object 1 and object 2 support your understanding of why momentum is conserved? Explain.

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Questions to Consider for Part Two

7. When object 1 has more mass, how does it move after the collision?

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8. When object 2 has more mass, how does object 1 move after the collision?

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9. Do each of the objects experience the same change in the magnitude of its velocity when their masses are not equal? Which one experiences a greater change in velocity?

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Courtesy of:
PhET Interactive Simulations
University of Colorado Boulder
https://phet.colorado.edu