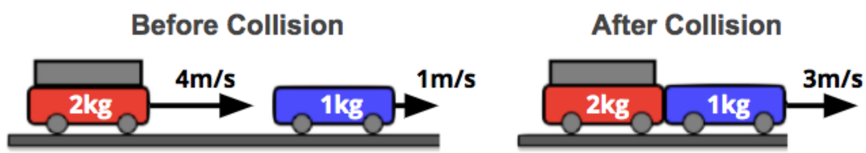
Solving Problems Using Momentum Conservation
Lesson Notes

The Law of Momentum Conservation:
For any collision occurring in an isolated system, the total amount of momentum possessed by objects within the system is conserved (i.e., remains unchanged).

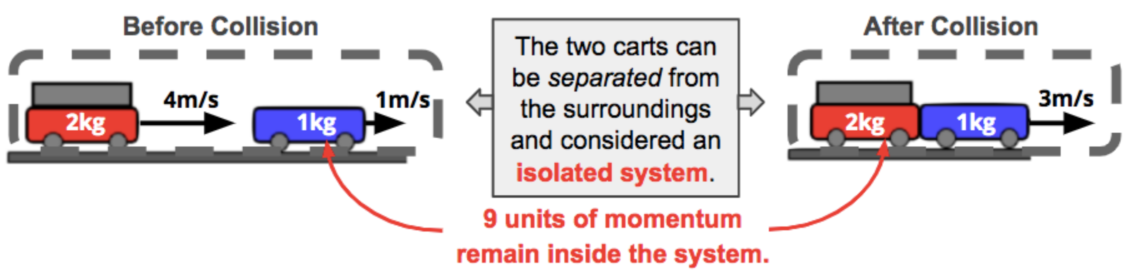


Before Collision:
8 kg•m/s + 1 kg• m/s

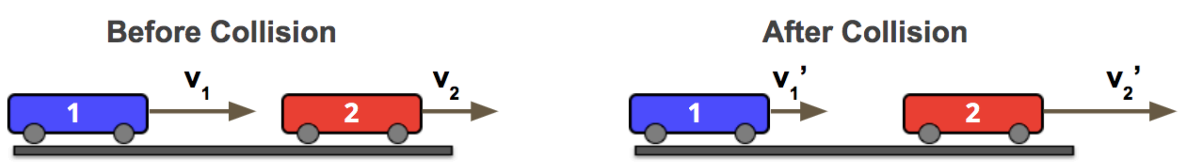
After Collision:
6 kg•m/s + 3 kg•m/s

Two colliding objects form an **isolated system** whenever the only unbalanced forces acting upon the objects at collision time are the forces acting between the objects.

Isolated Systems
For isolated systems, there is no transfer of momentum into or out of the system. The momentum possessed by the objects stays inside the system.



Momentum Conservation Equation
Momentum conservation can be used to develop an equation that relates pre-collision velocities to post-collision velocities.



	p Before Coll'n	p After Coll'n	Δp
Object 1	$m_1 \cdot v_1$	$m_1 \cdot v_1'$	$m_1 \cdot (v_1' - v_1)$
Object 2	$m_2 \cdot v_2$	$m_2 \cdot v_2'$	$m_2 \cdot (v_2' - v_2)$
System/Total	$m_1 \cdot v_1 + m_2 \cdot v_2$	$m_1 \cdot v_1' + m_2 \cdot v_2'$	0

Equation #2:

$$m_1 \cdot (v_1' - v_1) + m_2 \cdot (v_2' - v_2) = 0$$

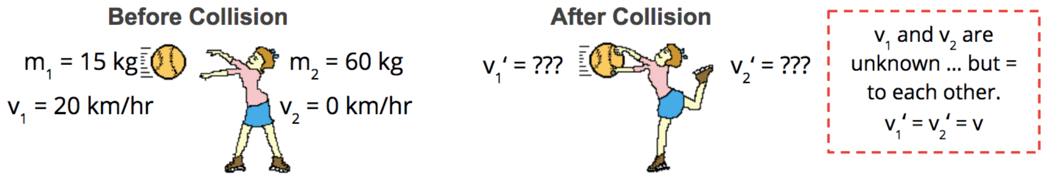
$$m_1 \cdot (\Delta v_1) + m_2 \cdot (\Delta v_2) = 0$$

$$\mathbf{m_1 \cdot \Delta v_1 = - m_2 \cdot \Delta v_2}$$

Equation #1: $\mathbf{m_1 \cdot v_1 + m_2 \cdot v_2 = m_1 \cdot v_1' + m_2 \cdot v_2'}$

Example 1: Hit-and-Stick Collision

A 15-kg medicine ball is thrown at a velocity of 20 km/hr to a 60-kg person who is at rest on ice. The person catches the ball and subsequently slides with the ball across the ice. Determine the velocity of the person and the ball after the collision.



	p Before Coll'n	p After Coll'n
Ball	15•20 = 300 kg•km/hr	15•**v**
Person	60•0 = 0 kg•km/hr	60•**v**
System/Total	300 kg•km/hr	300 kg•km/hr

15•**v** + 60•**v** = 300

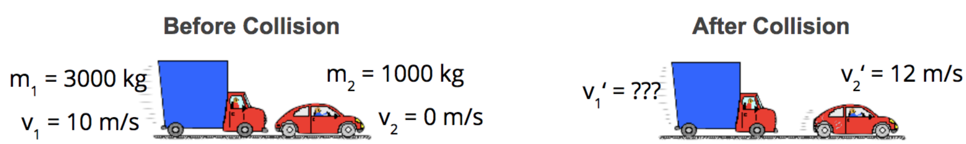
75•**v** = 300

v = 300/75

v = 4 km/hr

Example 2: Hit-and-Bounce Collision

A 3000-kg truck moving with a velocity of 10 m/s hits a 1000-kg parked car. The impact causes the 1000-kg car to be set in motion at 12 m/s. Determine the velocity of the truck immediately after the collision.



	p Before Coll'n	p After Coll'n
Truck	3000•10=30000 kg•m/s	3000•**v**
Car	1000•0 = 0 kg•m/s	1000•12=12000 kg•m/s
System/Total	30000 kg•m/s	30000 kg•m/s

3000•**v** + 12000 = 30000

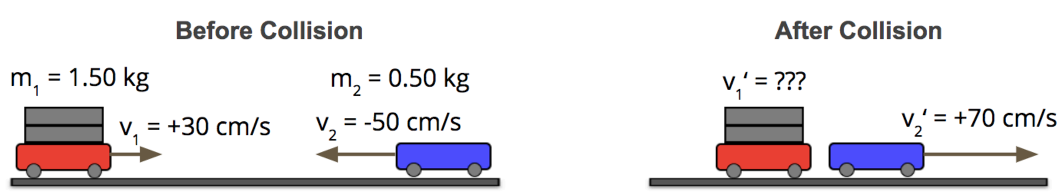
3000•**v** = 18000

v = 18000/3000

v = 6 m/s

Example 3: Direction is Important

A 1.50-kg red cart moving east at 30 cm/s collides with a 0.50-kg blue cart moving west at 50 cm/s. After the collision, the blue cart rebounds and moves east at 70 cm/s. What is the speed and direction of the red cart after the collision?



	p Before Coll'n	p After Coll'n
Red Cart	1.50•(+30) = +45 kg•cm/s	1.50•**v**
Blue Cart	0.50•(-50) = -25 kg•cm/s	0.50•(+70)=+35 kg•cm/s
System/Total	+20 kg•cm/s	+20 kg•cm/s

1.50•**v** + 35 = +20

1.50•**v** = -15

v = -15/1.5

v = -10 cm/s

Speed of 10 cm/s, West