

**?**

**W**

**2K**

**Apply** Newton’s

to momentum.

.

.

**Explain** how momentum is

**Define** and **calculate**

**Lesson Goals**

**Lesson Question**

**Words to Know**

*Fill in this table as you work through the lesson. You may also use the glossary to help you.*

|  |  |
| --- | --- |
|  | a quantity that has both a size and direction |
|  | the total momentum of all interacting objects is the same before and after an event |
|  | the measure of the motion of an object found by multiplying the object’s mass and velocity |



# Newton’s Third Law of Motion

* Newton’s of motion states that forces come in pairs that are equal in strength and opposite in direction.
* Man on car → Car pushes on man
* Ball pushes on racket Racket pushes on ball
* Books push on desk → Desk on books

**Slide**

* Units: kg • m/s

: a quantity that has both a size and direction.

•

* is the measure of the motion of an object found by multiplying the object’s mass and velocity.
  + Symbol: 𝑝

𝑝 = 𝑚𝑣

**Momentum**

**2**

*Solve the equation:*

* 𝑝 = *mv* = (2 kg)( 0.8 m/s)

• 𝑝 = 1.6 kg • m/s

to use: 𝑝 = 𝑚𝑣

•

: 𝑝

•

* 𝑀 = 2 kg
* 𝑉 = 0.8 m/s

:

•

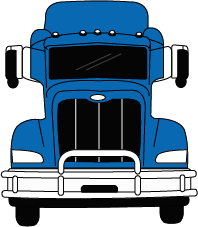
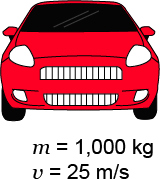
**Momentum of a Hammer**

**EXAMPLE**

What is the of a 2 kg hammer swung at 0.8 m/s?

**4**

**7**



momentum of interacting objects does not change.

𝑝𝑖 = 𝑝𝑓

states that the total

* The

**Law of Conservation of Momentum**

**Slide**

will have the greater momentum.

, the object with the greater mass

velocity will have the greater momentum.

* If two objects have the same

, the object with the greater

* If two objects have the same

**Mass, Velocity, and Momentum**

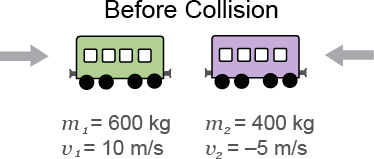
|  |
| --- |
| **Equal Momentum**  Car:   * 𝑝 = *mv* * 𝑝 = (1,000 kg)(25 m/s)   𝑚 = 1,000 kg  • 𝑝 = kg • m/s 𝑣 = 25 m/s |
|  |
| Truck:   * 𝑝 = *mv* * 𝑝 = (5,000 kg)(5 m/s)   • 𝑝 = kg • m/s  𝑚 = 5,000 kg  𝑣 = 5 m/s |

**Slide**

# Collisions in Which Objects Stick Together

* Two or more objects collide and to become one object with one velocity.
  + They individual masses .
  + All objects have the .

**9**



|  |  |
| --- | --- |
| **Before Collision**  Green train car:   * 𝑝 = *mv* * 𝑝 = (600 kg)(10 m/s) | Purple train car:   * 𝑝 = *mv* * 𝑝 = (400 kg)(−5 m/s) |
| • 𝑝 = kg • m/s | • 𝑝 = kg • m/s |
| Total momentum before collision:  • 6,000 kg • m/s + (−2,000 kg • m/s)  kg • m/s | Before Collision  𝑚1 = 600 kg 𝑚2 = 400 kg |
|  | 𝑣1 = 10 m/s 𝑣2 = −5 m/s |
| **After Collision** |  |
| Total momentum after collision: | After Collision |
| * 𝑝 = *mv* * 𝑝 = (1000 kg)(4 m/s) |  |
| = kg • m/s | 𝑚𝑓 = 1,000 kg  𝑣𝑓 = 4 m/s |

**Slide**

# Collisions in Which Objects Bounce Apart

* Two or more objects collide together and with separate velocities.
  + They their original masses.
  + The velocities may .

## Before Collision

Green train car:

* + - 𝑝 = *mv*
    - 𝑝 = (600 kg)(2 m/s)

• 𝑝 = kg • m/s

Purple train car:

* 𝑝 = *mv*
* 𝑝 = (400 kg)(‒4 m/s)

• 𝑝 = kg • m/s

Total momentum before collision:

• 1,200 kg • m/s + (‒1,600 kg • m/s) =

kg • m/s

## After Collision

Green train car:

* + 𝑝 = *mv*
  + 𝑝 = (600 kg)(−2 m/s)

• 𝑝 = kg • m/s

Before Collision

𝑚1 = 600 kg 𝑚2 = 400 kg

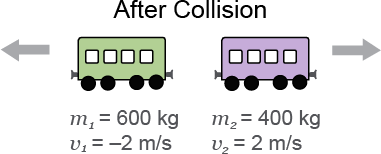
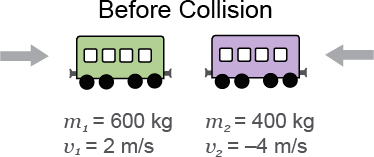
𝑣1 = 2 m/s 𝑣2 = −4 m/s

Purple train car:

* 𝑝 = *mv*
* 𝑝 = (400 kg)(2 m/s)

• 𝑝 = kg • m/s

**9**



Total momentum after collision:

• −1,200 kg • m/s + (800 kg • m/s)

= kg • m/s

After Collision

𝑚1 = 600 kg 𝑚2 = 400 kg

𝑣1 = −2 m/s 𝑣2 = 2 m/s

**Slide**

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**14**

the momentum of the cannonball moving right.)

𝑚𝑐𝑏𝑣𝑐𝑏 (The momentum of the cannon moving left equals

* 𝑚𝑐(−𝑣𝑐)

cannonball → Cannonball pushes cannon

* Cannon

.

* Newton’s third law describes action and reaction

momentum.

of motion can be applied to the conservation of

* Newton’s

**Newton’s Third Law of Motion and Momentum**

of a collision.

the

* Reducing the force exerted by action-reaction force pairs is done by extending

damage.

* Minimizing the force exerted in action-reaction force pairs

.

* Faster objects require greater changes in momentum to

or transferring momentum requires a force.

•

**Force, Momentum, and Collision Time**

What is momentum?

**Lesson Question**

**Slide**

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the collision increases.

exerted on an object during a collision decreases if the time of

* The

in momentum.

* Forces cause

that objects will also have equal and opposite momenta when momentum is

conserved.

of motion about action and reaction forces means

* Newton’s

momentum of all objects in a collision or explosion must be the same before and

after the collision or explosion.

states that the total

* The

𝑝 = 𝑚𝑣.

is the product of an object’s mass and velocity, found by the

•

**Review: Key Concepts**

**Answer**

**2**

*Use this space to write any questions or thoughts about this lesson.*