Momentum & Impulse

AP Physics

Linear Momentum is a measure of the object's _____ and _____:

$$p = mv$$

SI Unit: _____

Momentum is a _____ quantity!

Quick Test

A collection of particles has a total kinetic energy of 0. What can we say about the momentum of the system?

a. The momentum is positive.

b. The momentum is negative.

c. The momentum is zero.

d. The momentum is either positive or negative, but not zero.

From Newton's second law:

Force =

Acceleration =

Therefore:

Which means:

(How Newton originally wrote the second law)

Impulse- the change in momentum

$I =$

$I =$

Example

A car with a mass of 1000 kg collides into a wall. The car is initially traveling at 10m/s to the left. The car hits the wall and rebounds back at 2m/s to the right. If the collision occurred in 0.1 s, what force is imparted to the person in the car?

a. 100,000 N

b. 60,000 N

c. 80,000 N

d. 120,000 N

F =

Crash Test Video: (3:00)

https://www.youtube.com/watch?annotation_id=annotation_2912448293&feature=iv&src_vid=f2y7lx8KQn8&v=YdjN7dIXRXo

Honda: 40 km/h = 10 m/s

In contact with person for 1 m; which means in contact with person for about 0.1s.

V_o = 0 m/s V_f= 10 m/s mass of person: 100 kg

F =

A 0.500 kg football is thrown toward the east with a speed of 10.0 m/s. A stationary receiver, whose mass is 100 kg, catches the ball and brings it to rest in 0.040 s. During this time period, what is the magnitude of the acceleration of the football?

a. 5.4

b. 0.2

c. 130

d. 250

Conservation of Momentum

- This physical law states that, in a collision, the total momentum of the particles in the system is conserved and must not change:
- Notation:

- How can momentum equal 0, if possible?

Consider this simple collision: (Draw illustration before and after rebound.)

Two particles collide and rebound.

m_1= 3kg

m_2= 4kg

V_{1i}= 1m/s

V_{2i} =-2m/s

V_{1f} = -5m/s

Initial Momentum =

V_{2f} =

Dodgeball

- https://www.youtube.com/watch?annotation_id=annotation_2307832917&feature=iv&src_vid=CdDFhU0j4IA&v=16US1Y6Ridg#t=3m15s

- Body 1: Ball → m = 0.5 kg; V_i= ?; V_f= 0 m/s

- Body 2: Goodman → m= 100 kg ; V_i= 0; V_f= 2 m/s

Collisions

There are two types of collisions: elastic and inelastic.

Elastic: _____ and _____ are conserved.

- The objects bounce off of one another and no energy is lost to sound, heat, or deformation of the objects

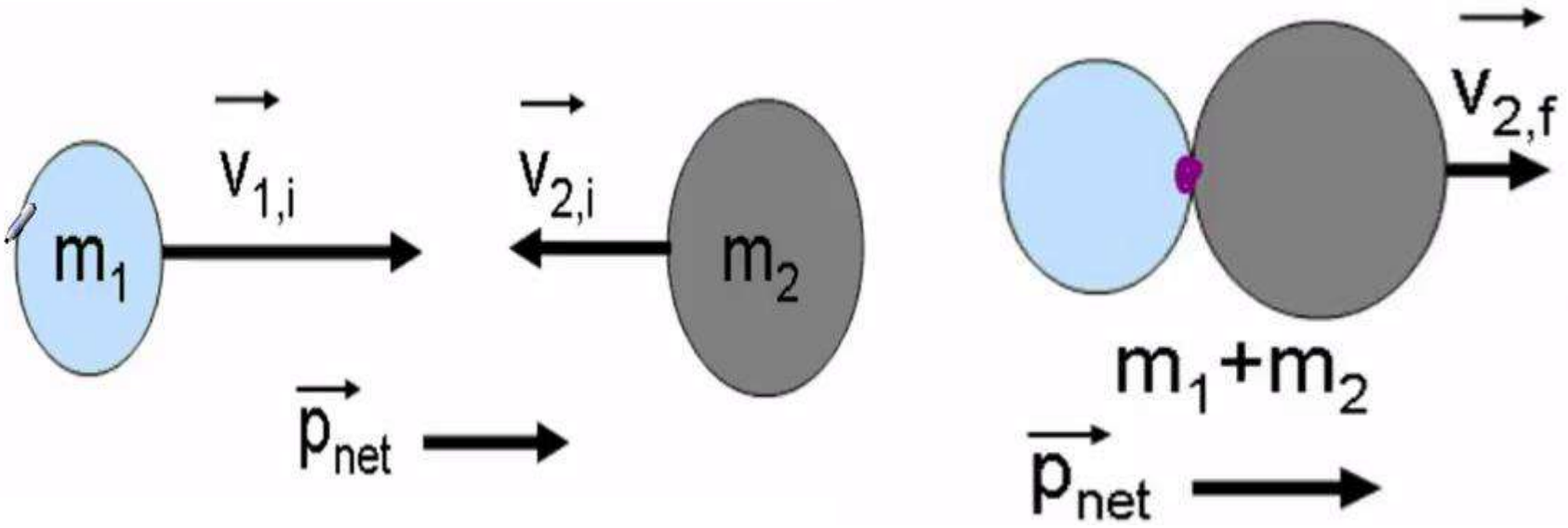
- There are not many examples of this in the universe. What are some?

Do gas particles really collide? What is an almost elastic collision?

Inelastic collisions: Only _____ is conserved; _____ is not conserved

- these are most collisions in the universe
- collision of two cars

Perfectly Inelastic: objects stick together

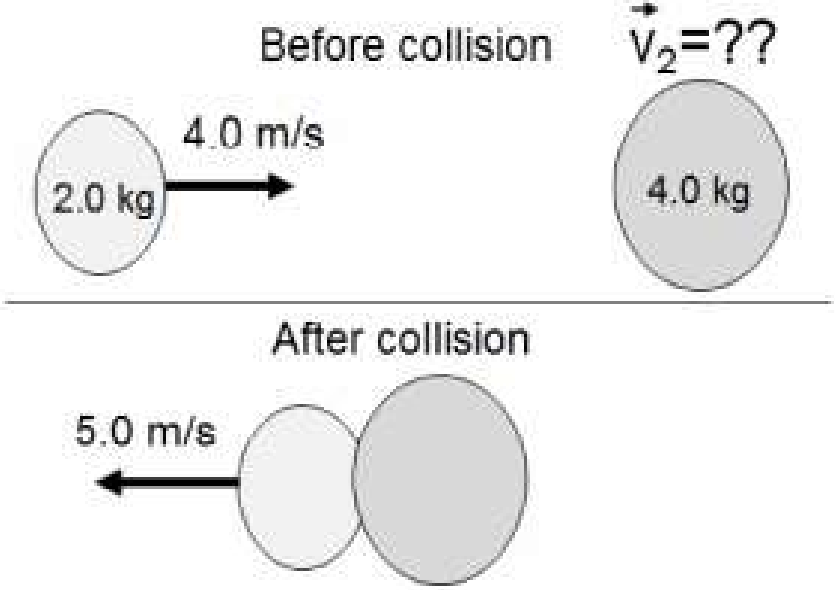


Perfectly Inelastic Collisions

The objects stick together upon colliding so that they both have the same velocity.

Momentum is conserved in EVERY collision, while energy is not.

Consider this perfectly inelastic collision. What is the initial velocity of the 4.0 kg ball?



a. 12 m/s to the left
b. 9.5 m/s to the left
c. 5.5 m/s to the left
d. 8.0 m/s to the right
e. 7.0 m/s to the right