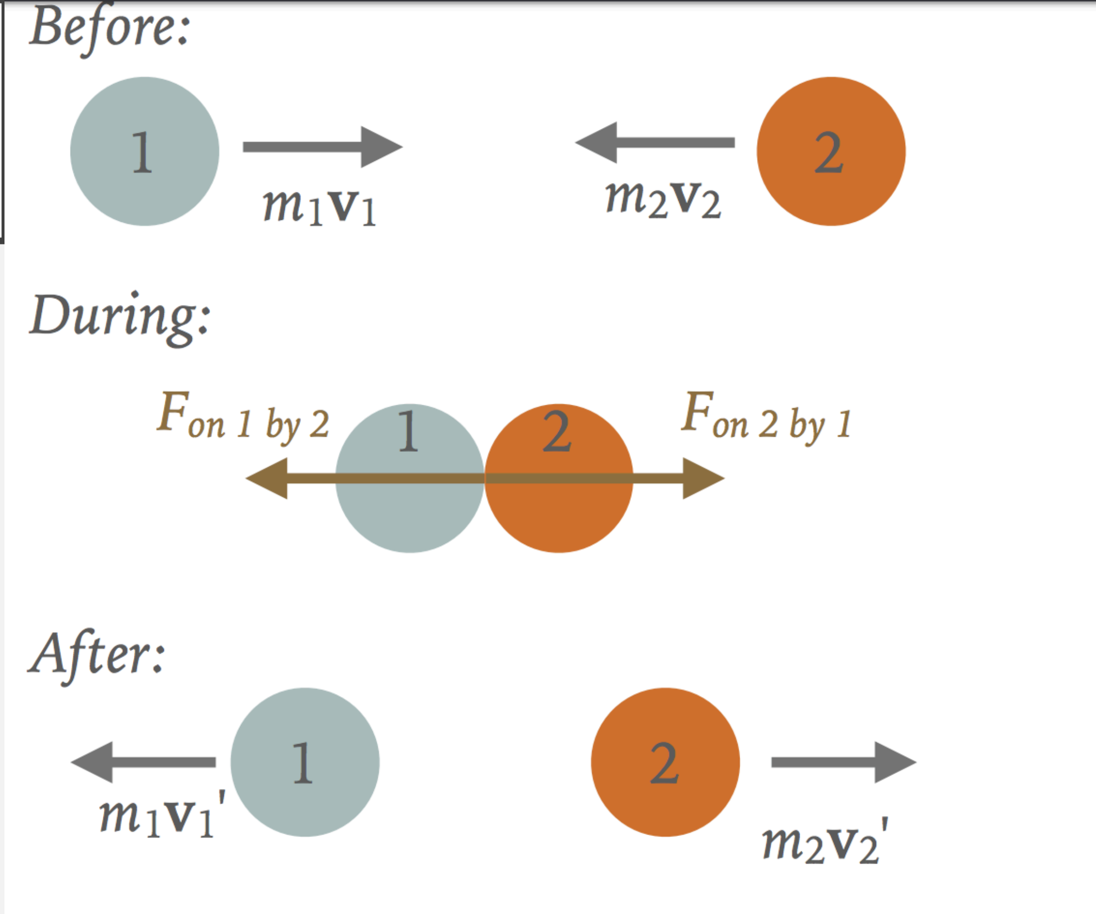
CONSERVATION OF MOMENTUM



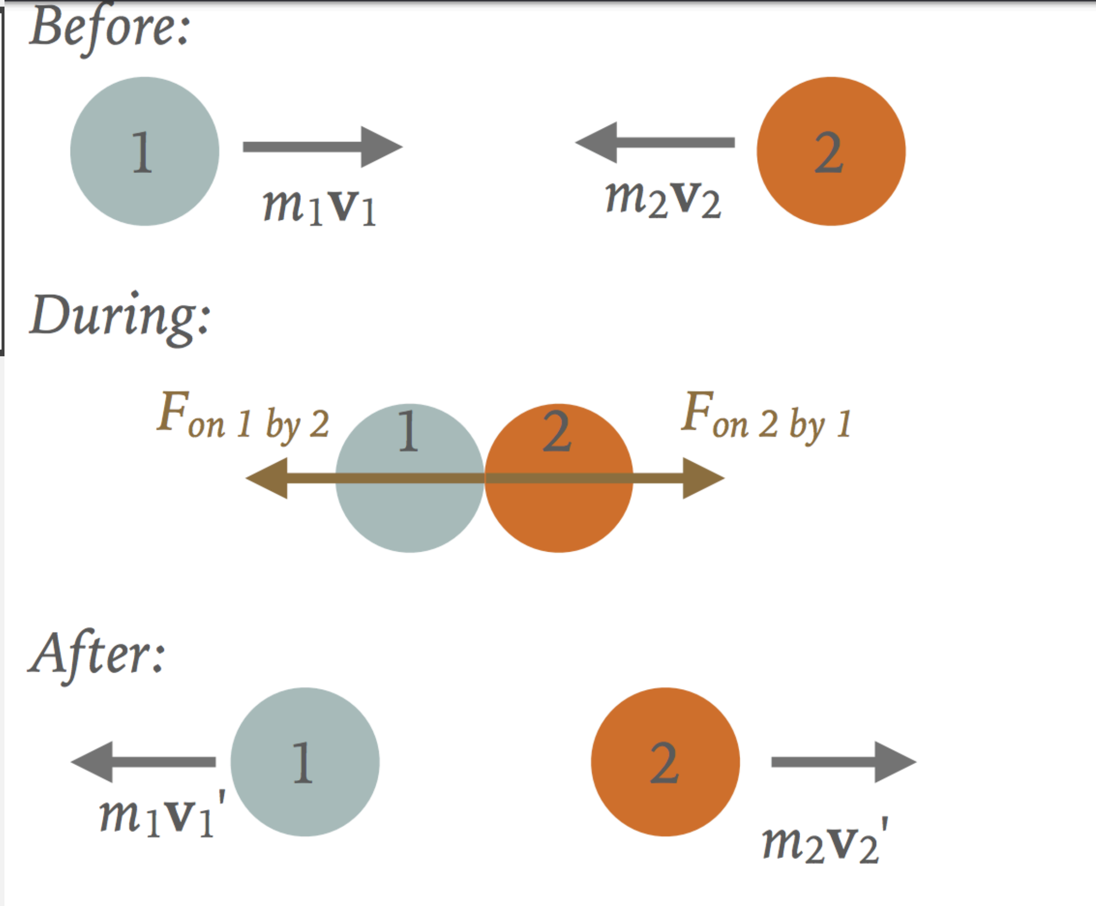
- Picture 2 billiard balls set on a head-on collision (ignore any retarding forces)
- After collision, the two momentum of the balls will change
- But the **sum** of the momenta will be the same before and after the collision

CONSERVATION OF MOMENTUM

$P_{before} = P_{after}$

$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

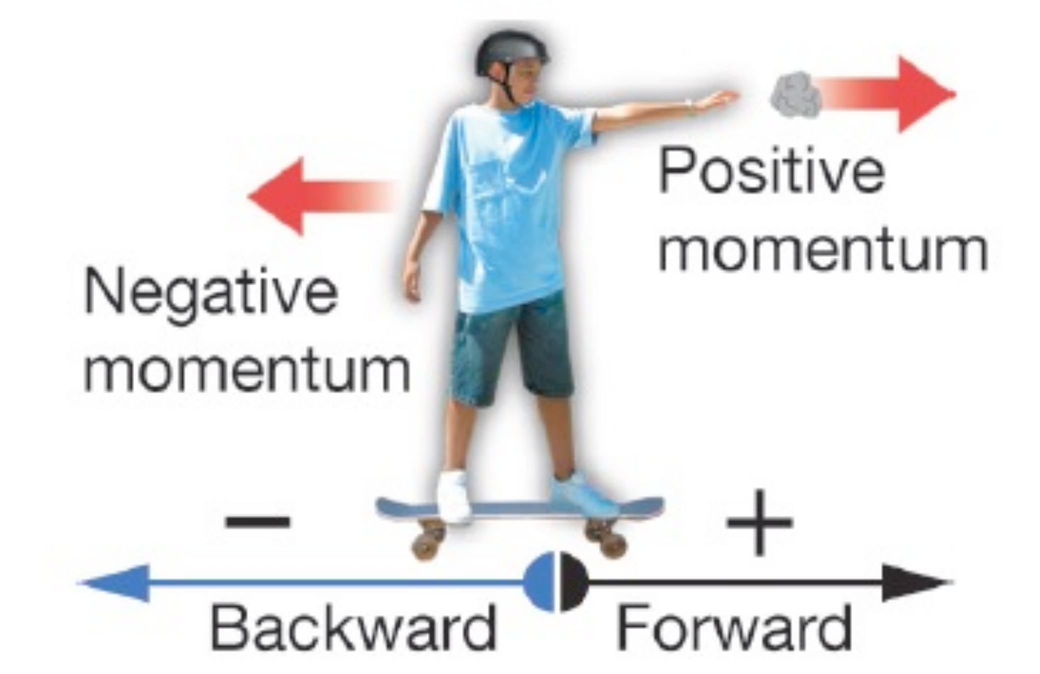
The total momentum of the two-ball system is **conserved**



LAW OF CONSERVATION OF MOMENTUM

The total momentum of an isolated system remains constant

- **System:** Set of objects that interact with each other
- **Isolated system**: system in which the only forces present are those between the objects of the system



If you throw a rock forward from a skateboard, you will move backward in response.

KIRBY TURNS INTO A ROCK AND FREE FALLS. IS MOMENTUM CONSERVED?

It is if you include the Earth in your system!

CONSERVATION OF MOMENTUM AND ROCKETS

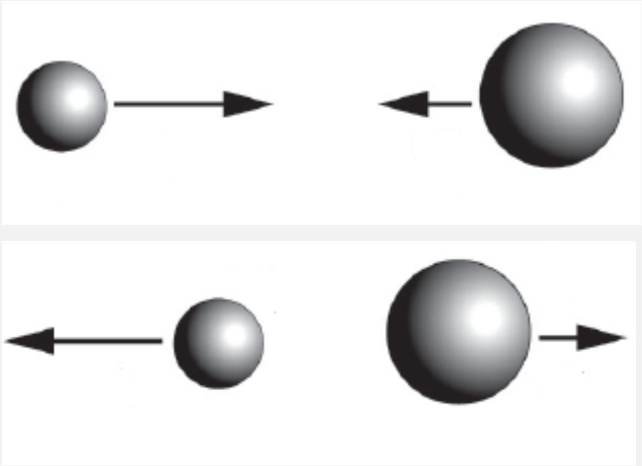
- Before the engines fire, the total momentum (rocket + fuel) is zero
- Backward momentum of expelled exhaust = forward momentum of rocket
- Similar to Newton's 3rd Law!

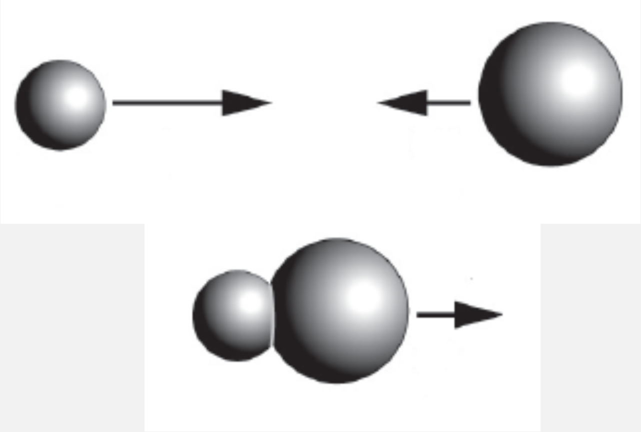
RECOIL

- Calculate the recoil velocity of a 5.0 kg rifle that shoots a 0.050 kg bullet at 120 m/s
- $m_B v_B + m_R v_R = m_B v_B' + m_R v_R'$ ($0 = 0.050kg \times 120m/s + 5.0kg + v_R'$)
- $v_R' = -1.2$ m/s
- What does the negative sign mean?

COLLISIONS IN ONE DIMENSION

- A *collision* occurs when two or more objects hit each other.
- During a collision, momentum is transferred from one object to another, but **total momentum is conserved**
- Collisions can be ***elastic*** **or** ***inelastic*****.**





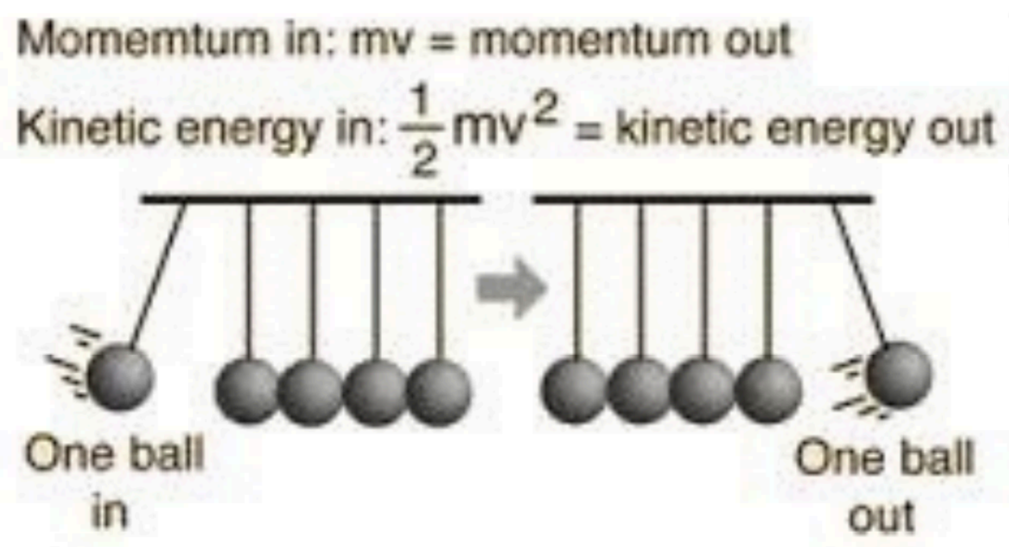
ELASTIC COLLISIONS

If the two objects is a collision are

- Very hard
- No heat is produced in the collision

Then kinetic energy is also conserved

These collisions are **perfectly elastic**



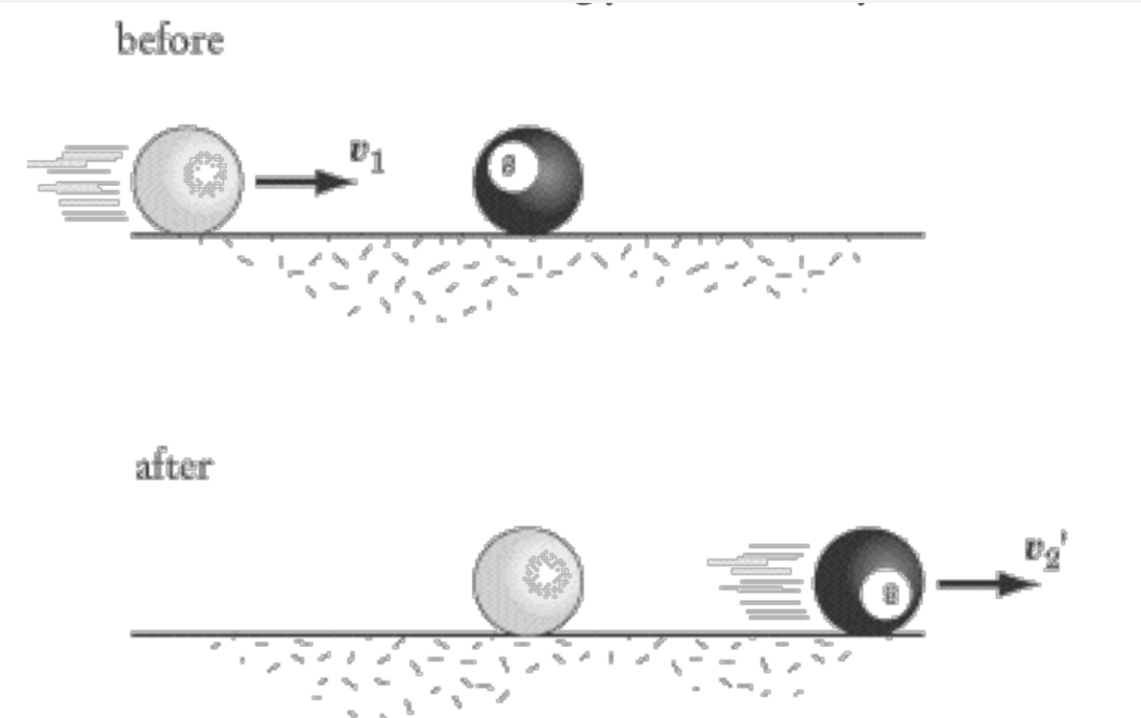
ELASTIC COLLISIONS

A billiard ball of mass *m* moving with speed *v* collides head-on with another ball of equal mass at rest. What are the speeds of the two balls after the collision, assuming it is perfectly elastic and there is no spin?

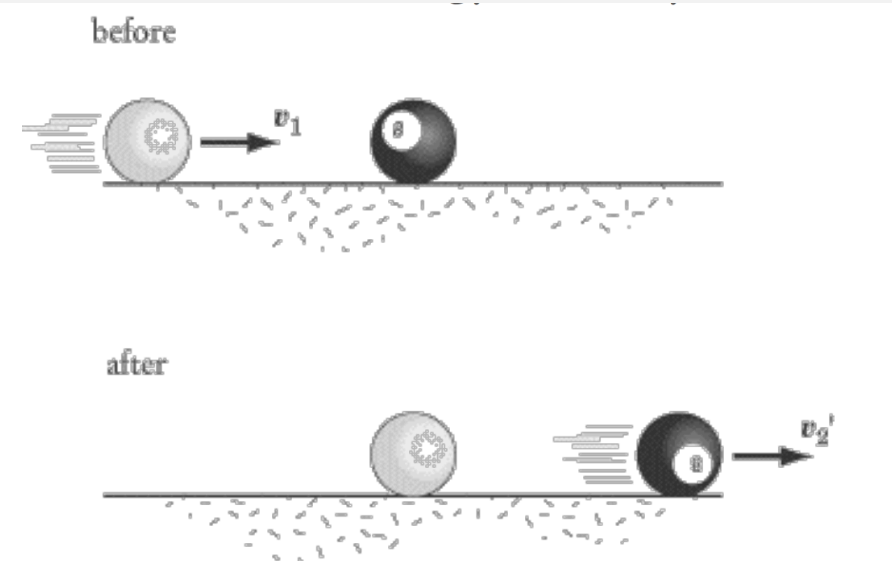
$p_{before} = p_{after}$

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

$\boldsymbol{v_1' = 0, v_2' = v}$



AN IMPORTANT DERIVATION: CONSERVATION OF KE AND CONSERVATION OF MOMENTUM



(Giancoli pg. 188-189)

ELASTIC COLLISIONS

A proton of mass m_p = 1.67 x 10^{-27} kg traveling at 3.60 x 10^4 m/s has an elastic head-on collision with an alpha particle (helium nucleus, m_a = 6.64 x 10^{-27} kg) initially at rest.

What are the velocities of the proton and helium nucleus after the collision?

$p_{before} = p_{after}$ $KE_i = KE_f$

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

$\mathbf{v_1 - v_2 = v_2' - v_1'}$