Momentum

- **Recall:** All objects have inertia (the resistance to a change in motion)
- When the object is in motion, we refer to the inertia as **momentum**
- The **momentum** of an object is equal to: **mass × velocity**
- If the direction of the object is not important, we can use: **mass × speed**

Momentum

$p = mv$

ρ = momentum

(Kgm/s)

m = mass

(Kg)

v = velocity or speed

(m/s)

Momentum

1. A car with a mass of 1500 kg is traveling west at 60 m/s. What is the car's momentum?

$\rho = m \times v$

$\rho = 1500\ kg \times 60\ m/s$

$\rho = 90{,}000\ kgm/s\ west$

Momentum

2. A horse with a mass of 400 kg is traveling at 12 m/s. What is the horse's momentum?

Volunteer?

Momentum

3. A man with a mass of 90 kg is traveling at 3 m/s. What is the man's momentum?

Volunteer?

Law of Conservation of Momentum

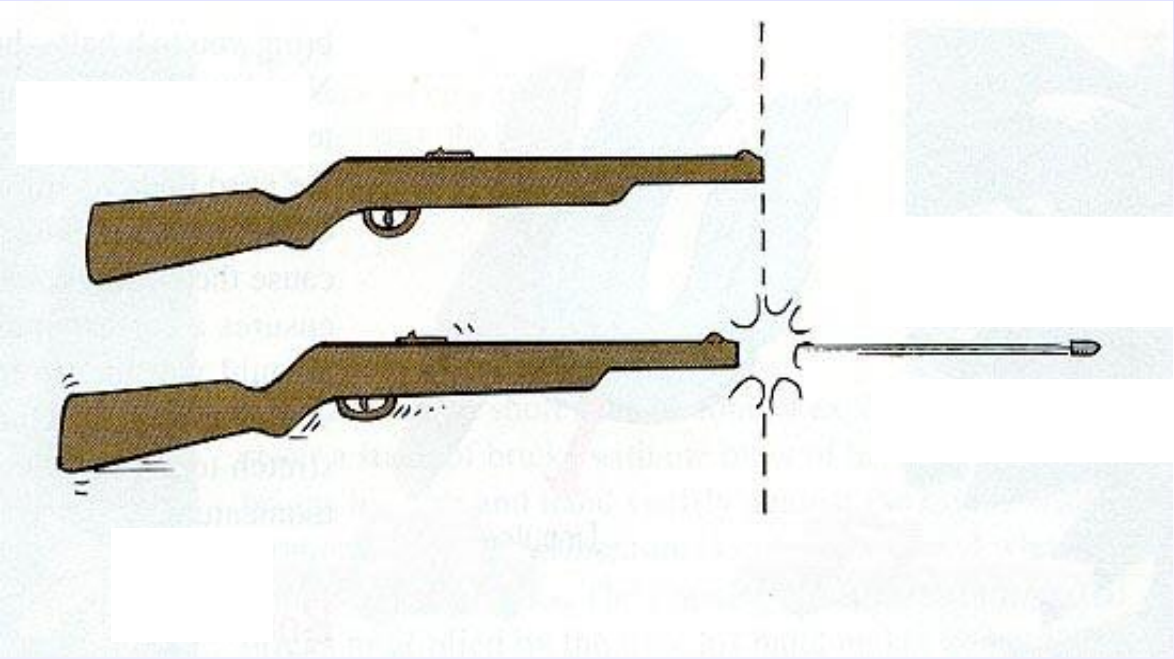
Newton's **1st Law of Motion** tells us that the velocity of an object remains the same without an outside force.

The **mass** of the object also remains the same.

Therefore . . .

The momentum of a system remains **unchanged** if no external **forces** are present.

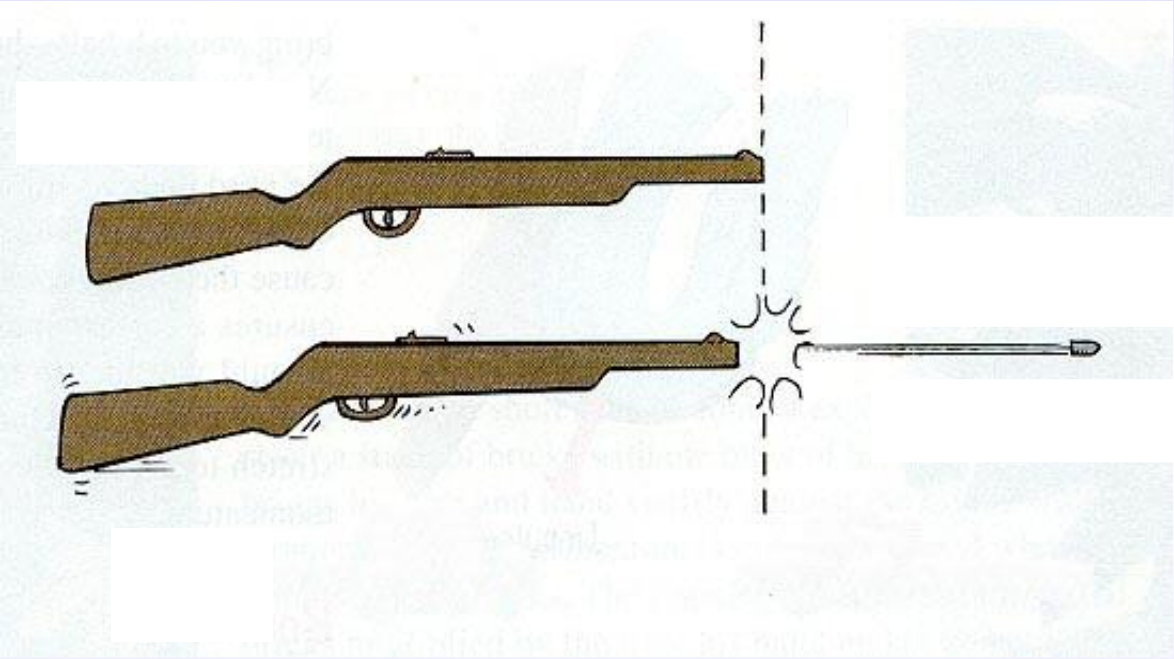
Law of Conservation of Momentum



A bullet is shot from a gun.

What do we know about the force exerted on the bullet and the gun?

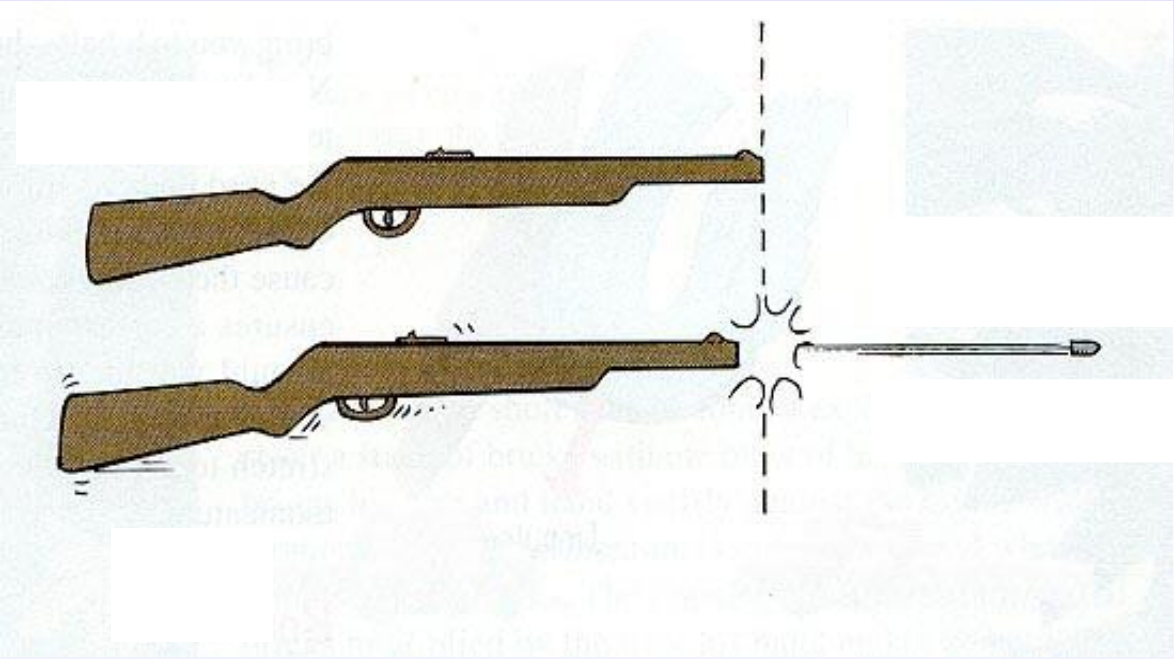
Law of Conservation of Momentum



A bullet is shot from a gun.

Is the momentum conserved for the bullet? Why or why not?

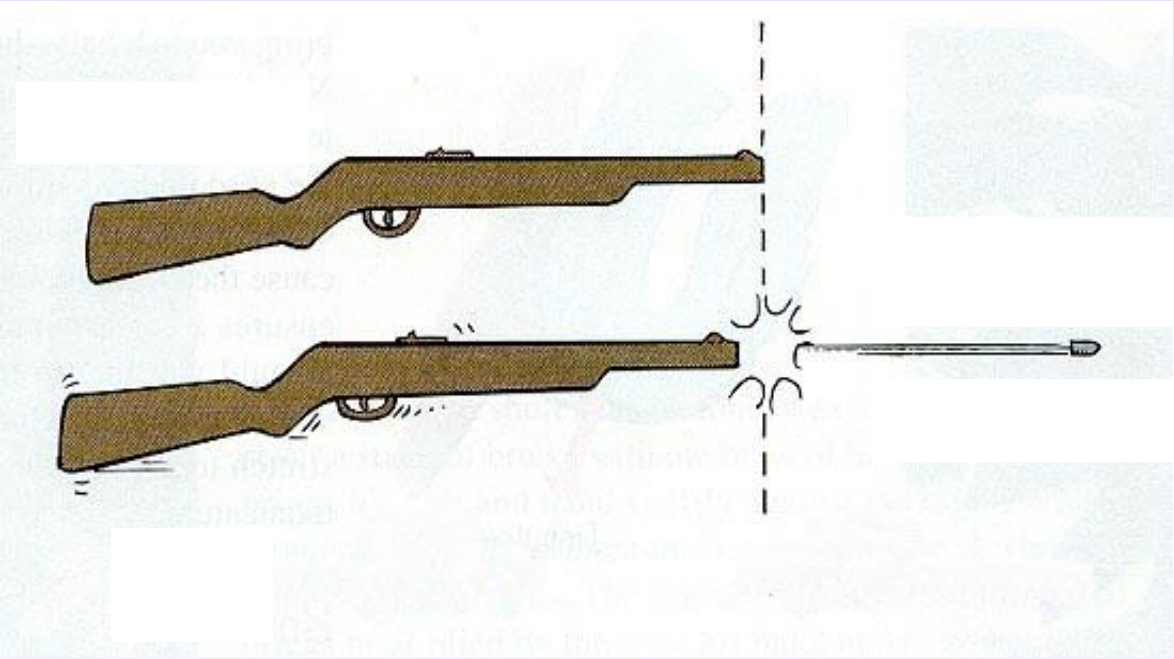
Law of Conservation of Momentum



A bullet is shot from a gun.

Is the momentum conserved for the gun? Why or why not?

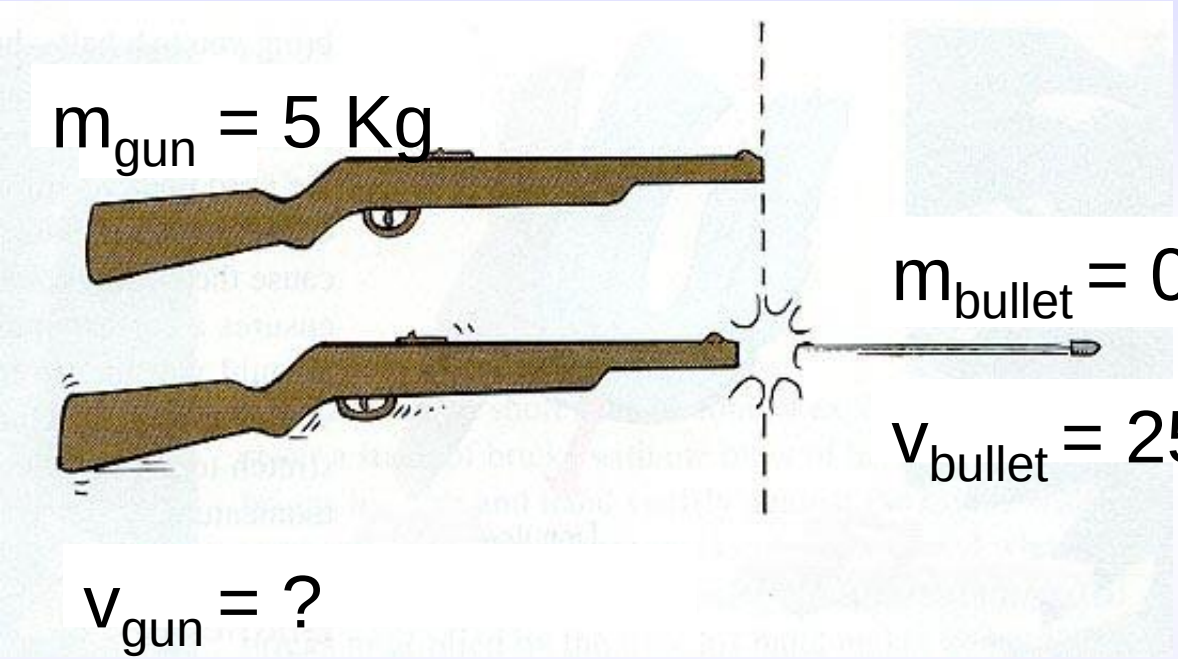
Law of Conservation of Momentum



A bullet is shot from a gun.

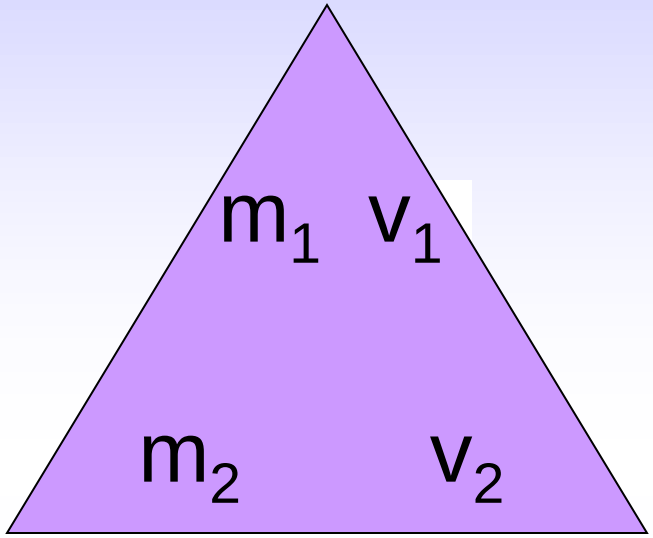
Is the momentum conserved for the gun-bullet system? Why or why not?

Law of Conservation of Momentum



We can calculate the recoil velocity of the gun using the law of conservation of momentum.

Law of Conservation of Momentum



$m_{bullet} = 0.010$ Kg

$v_{bullet} = 250$ m/s

$m_{gun} = 5$ Kg

$v_{gun} = ?$

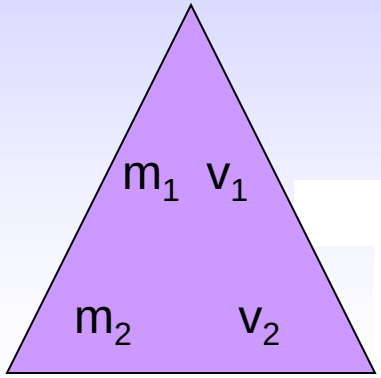
$$m_1 \times v_1 = m_2 \times v_2$$

$$v_2 = \frac{m_1 \times v_1}{m_2}$$

$$v_2 = \frac{0.01 \text{ Kg} \times 250 \text{ m/s}}{5 \text{ Kg}}$$

$$v_2 = 0.5 \text{ m/s}$$

Law of Conservation of Momentum

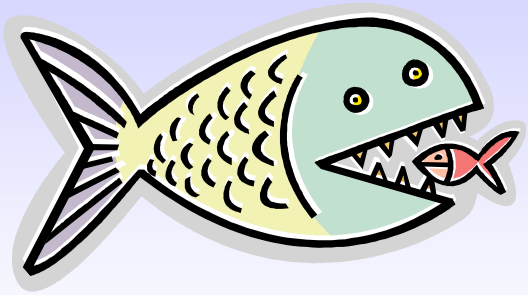


$m_1 =$

$v_1 =$

$m_2 =$

$v_2 =$



A 5 kg fish swimming at 2 m/s swallows an absent minded 1 kg fish swimming toward it at a velocity that brings both fish to a halt immediately after lunch. What is the velocity of the smaller fish before lunch?

Volunteer?