# Physics 2204

# Date:_____

***Last class:**

***Unit 2: Dynamics***

***-Momentum & Impulse***

***Today:**

***Unit 2: Dynamics***

**-Conservation of Linear Momentum**

# Conservation of Momentum

**You may have heard the saying, "*Energy cannot be created or destroyed.*"**

This is called a conservation law. It means that in a closed system, no matter what the event, the total energy before the event will equal the total energy after the event.

It implies that energy can change its form or be distributed, but its total quantity remains the same. This concept will be explained further in the energy unit.

The conservation of linear momentum is very similar. The total momentum of a system before a collision is the same as after a collision. It also implies that the object's motions will change and the momentum will be distributed, but the sum total of momentum for the system remains the same.

In mathematical form, the conservation of momentum is:

$$\vec{p}_{\text{total}_{\text{initial}}} = \vec{p}_{\text{total}_{\text{final}}}$$

$$\text{or } \vec{p}_{\text{T}_\text{o}} = \vec{p}_{\text{T}_\text{f}}$$

# Keeping Track of the Situation

To keep our workings organized and easy to follow, when doing problems involving two or more objects in a collision, we use:

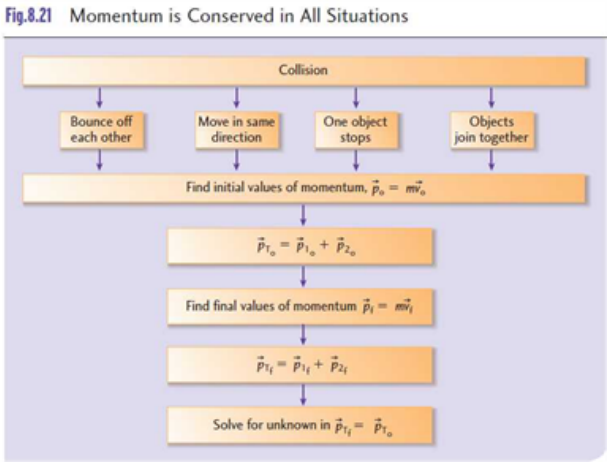
- “o” to denote “initial” or “original”
- “f” to denote “final.”

We use the numbers 1 and 2 to denote the colliding objects. When two objects collide, the values of their momenta can be related by the equation

$$m_1\vec{v}_{1_o} + m_2\vec{v}_{2_o} = m_1\vec{v}_{1_f} + m_2\vec{v}_{2_f}$$

**When objects collide, there can be a variety of resulting scenarios.**

**As long as we can keep track of all given values, we should be able so solve problems involving each of these types.**




## Example # 1:Calculating the momentum of objects initially at rest (recoil situations)

Consider two hockey players, both at rest on the ice. The 90-kg Montreal Canadiens player pushes the 105-kg Ottawa Senators’ player. Find the velocity of the Senator if the Canadien moves back at 10 km/h after the push.

Givens:

## Example # 2:Calculating the momentum of objects initially at rest (Motion from 1 object to another)

"A golf ball of mass 50.0 g is hit by a golf club at a speed of 35 m/s. If the effective mass of the club head is 0.32 kg, what velocity will the ball have just after the impact?"

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## Example #2: Calculating the momentum of objects in motion

Calculate the initial velocity of the American rugby player if she tackles a stationary Canadian player, causing both of them to move off with a velocity of 5 km/h. Both rugby players have a mass of 75 kg.

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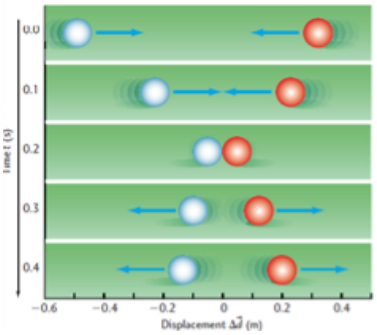
## Example #3-Recoil in objects initally in motion

Two billiard balls are shot towards each other at the same time (Fig. 8.25). They hit and recoil. If the velocity of ball 1 is 2.0 m/s to the right, and the velocity of ball 2 is 1.2 m/s to the left, find the velocity of ball 2 after the collision if ball 1 recoils with a velocity of 0.4 m/s.

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## So Many Types of Collisions!

Fig.8.24

According to the law of conservation of energy, the total amount of energy involved in a collision is also conserved.

In some collisions, the total amount of kinetic energy is conserved. (Energy of Motion) We will learn more about Kinetic Energy in the next unit.

- -This type of collision is referred to as an elastic collision.
- -When two objects collide, then go off on their separate ways, ei. the billiard balls.
- -They do not stick together.

If the total final kinetic energy is different than the total initial kinetic energy in a collision, then the collision is said to be an inelastic collision.

- -Typically (but not aways!) scenarios such as when objects collide, then move off together, ie. a car crash.

Momentum is conserved for both cases. In inelastic collisions, kinetic energy is lost to other forms of energy, such as heat and light.

# In-Class/Homework

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