

The background of the slide is a blurred image of several colorful balls, each with a white circular label containing a number. The balls are in various colors including yellow, blue, orange, purple, green, and pink. The numbers visible on the balls are 1, 3, 4, 6, and 7. The word "Momentum" is written in a large, stylized, italicized font across the middle of the slide, with each letter in a different color: M (purple), o (blue), m (green), e (yellow), n (orange), t (red), u (pink), and u (magenta).

Momentum

Collisions

- There is a collision!

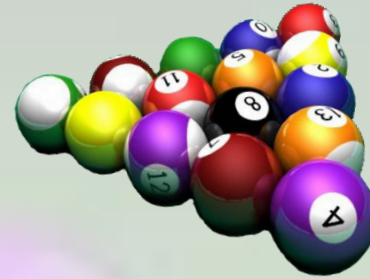


- Now what?!
- What happens during a collision depends on the masses and velocities of the colliding objects before the collision.



Collision Scenarios

- Consider a game of pool:



- The cue ball collides with another pool ball:
 - A collision can change the motion of either or both objects.
 - A collision can cause a change in speed, direction, or both for any of the objects involved.



Comparing Collisions

- In a collision between a cue ball and a pool ball, the masses are about the same.
- In a collision between a smart car and a garbage truck they are not.
- This affects the outcome.



Inertia and Mass

- The garbage truck has more mass than the smart car.

- Mass = the amount of matter in an object



- It is harder to slow the garbage truck down.

- The more mass an object has, the harder it is to change its motion.



- Inertia = tendency of matter to resist a change in its motion.

- The garbage truck has more inertia than the smart car.



Inertia and Speed

- A sports car moves faster than a smart car.



- It would be easier to stop a slow smart car than a speedy sports car.
- It has less inertia.
 - The faster an object is moving, the harder it is to change its motion.
 - Faster objects have more inertia.



Defining Momentum



- Momentum = measure of the difficulty in stopping a moving object.
- Momentum is the product of the mass and velocity
 - If p is momentum,
 - m is mass,
 - and v is velocity
 - $p = mv$

The background of the slide features a collection of billiard balls, each with a white circular label containing a number. The balls are in various colors including yellow, blue, orange, red, purple, green, and pink. They are arranged in a scattered pattern across the slide, with some in sharp focus and others blurred. The overall background has a light green gradient.

It's the Law!

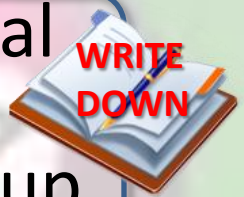
CONSERVATION OF MOMENTUM

Defining Conservation

- In billiards, when one billiard ball hits another, it slows down, and/or reverses direction, but the other speeds up making the total momentum constant.



- It's not always obvious that the momentum is constant, because eventually the billiard balls slow down due to friction, an outside force.
- Law of Conservation of Momentum = the total momentum of a group of objects remains constant unless outside forces act on the group.



Examples of Conservation

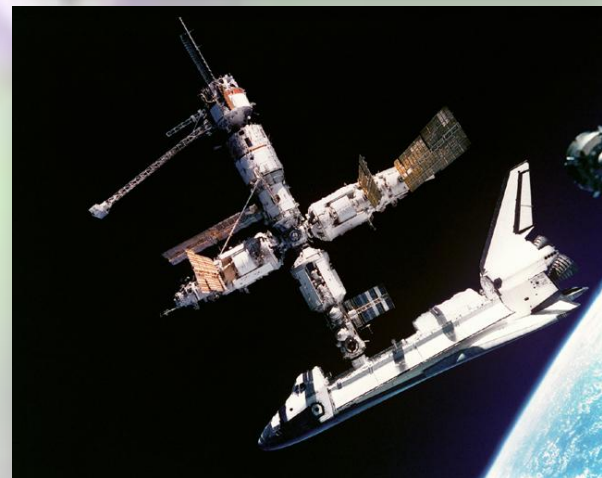
- Objects bounce off each other.

- Billiards
- Bowling



- Objects stick together.

- Coupling train cars
- Space shuttle docking with space station
- Colliding snowballs



Sample Problem

Example: You are standing still on skates. Your mass is 48 kg. Some one tosses you a 2 kg back pack with a velocity of 5 m/s east. What is your velocity after you catch the back pack?

- **Step 1:** Find the total momentum by adding the momentums of each object.

- $p_{total} = p_{backpack} + p_{yours}$

- $p_{total} = m_{backpack}v_{backpack} + m_{yours}v_{yours}$

- $p_{total} = (2\text{ kg})(5\text{ m/s east}) + (48\text{ kg})(0\text{ m/s}) = 10\text{ kg}\cdot\text{m/sec east}$

- **Step 2:** Use the total momentum and the total mass to solve for the velocity.

- $p_{total} = m_{total}v_{total}$

- $10\text{ kg}\cdot\text{m/s east} = (2\text{ kg} + 48\text{ kg})v_{total}$

- $10\text{ kg}\cdot\text{m/s east} = (50\text{ kg})v_{total}$

- $0.2\text{ m/s east} = v_{total}$

