Momentum Conservation



Just like the third law of motion says that forces are equal and opposite, changes in momentum are equal and opposite. This is because when objects exert forces on each other, their motion is affected.

The law of momentum conservation states that if interacting objects in a system are not acted on by outside forces, the total amount of momentum in the system cannot change.

The formula below can be used to find the new velocities of objects if both keep moving after the collision.

the momentum of a system before = the total momentum of a system after

$$m_1 v_{1(\text{initial})} + m_2 v_{2(\text{initial})} = m_1 v_{3(\text{final})} + m_2 v_{4(\text{final})}$$

If two objects are initially at rest, the total momentum of the system is zero.

the momentum of a system before a collision = 0

For the final momentum to be zero, the objects must have equal momenta in opposite directions.

0 = the momentum of a system after a collision

$$0 = m_1v_3 + m_2v_4$$

 $m_1v_3 = -(m_2v_4)$



Example 1: What is the momentum of a 0.2-kilogram steel ball that is rolling at a velocity of 3.0 m/sec?

momentum =
$$m \times v = 0.2 \text{ kg} \times \frac{3 \text{ m}}{\text{sec}} = 0.6 \text{ kg} \cdot \frac{m}{\text{sec}}$$

Example 2: You and a friend stand facing each other on ice skates. Your mass is 50 kilograms and your friend's mass is 60 kilograms. As the two of you push off each other, you move with a velocity of 4 m/sec to the right. What is your friend's velocity?

| Looking for Your friend's velocity to the left. | Solution $m_1v_3 = -(m_2v_4)$ $(50 \text{ kg})(4 \text{ m/sec}) = -(60 \text{ kg})(v_4)$ $\frac{200 \text{ kg-m/sec}}{-(60 \text{ kg})} = v_4$ $-3.33 \text{ m/sec} = v_4$ Your friends velocity to the left is 3.33 m/sec. |
|---|---|
| Given Your mass of 50 kg. Your friend's mass of 60 kg. Your velocity of 4 m/sec to the right. | |
| Relationship $m_1\nu_3 = -(m_2\nu_4)$ | |

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