Momentum and Collisions

Momentum

The momentum of an object is given by the equation: $momentum = mass \times velocity$ $p = mv$

Since it depends on the velocity and not speed, momentum is a vector quantity. If we assign a direction to be positive for example if → was positive, an object with negative velocity would be moving ←. It would also have a negative momentum.

Momentum is measured in kilogram metres per second, kg m/s or kg m s^{-1}

Conservation

In an isolated system (if no external forces are acting) the linear momentum is conserved.

We can say that: *the total momentum before = the total momentum after*

The total momentum before and after what? A collision or an explosion.

Collisions

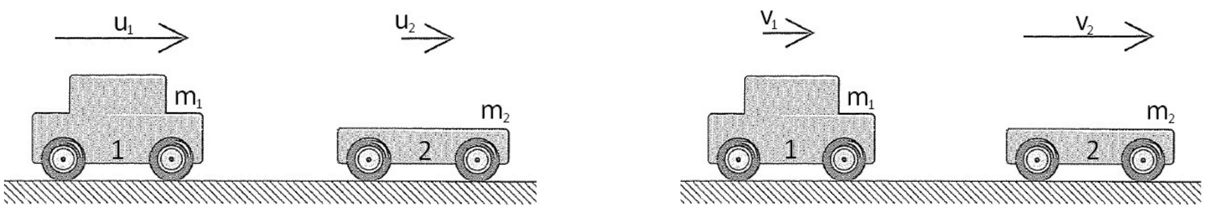
There are two types of collisions; in both cases the momentum is conserved.

Elastic – *kinetic energy in conserved, no energy is transferred to the surroundings*

If a ball is dropped, hits the floor and bounces back to the same height it would be an elastic collision with the floor. The kinetic energy before the collision is the same as the kinetic energy after the collision.

Inelastic – *kinetic energy is not conserved, energy is transferred to the surroundings*

If a ball is dropped, hits the floor and bounces back to a lower height than released it would be an inelastic collision. The kinetic energy before the collision would be greater than the kinetic energy after the collision.



Before **After**

In the situation above, car 1 and car 2 travel to the right with initial velocities u_1 and u_2 respectively. Car 1 catches up to car 2 and they collide. After the collision the cars continue to move to the right but car 1 now travels at velocity v_1 and car 2 travels a velocity v_2. [→ is positive]

Since momentum is conserved the total momentum before the crash = the total momentum after the crash.

The total momentum before is the momentum of A + the momentum of B

The total momentum after is the new momentum of A + the new momentum of B

We can represent this with the equation: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Explosions

We look at explosions in the same way as we look at collisions, the total momentum before is equal to the total momentum after. In explosions the total momentum before is zero. [→ is positive]

Before **After**

If we look at the example above we can see that the whole system is not moving, so the momentum before is zero. After the explosion the shell travels right with velocity v_2 and the cannon recoils with a velocity v_1.

The momentum of the system is given as: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

So the equation for this diagram would be: $0 = m_1v_1 + m_2v_2$

But remember, v_1 is negative so: $0 = -m_1v_1 + m_2v_2$ → $m_1v_1 = m_2v_2$