Momentum

To be able to calculate momentum and know the units
To be able to find the velocity of an object after a collision or explosion

Momentum

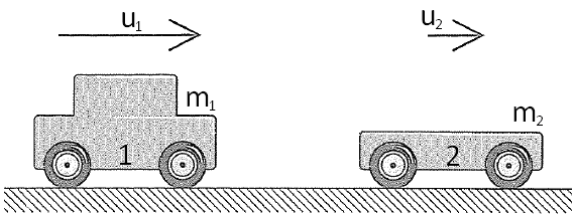
The momentum of an object is given by the equation: $momentum = mass \times velocity$ $p = mv$

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.

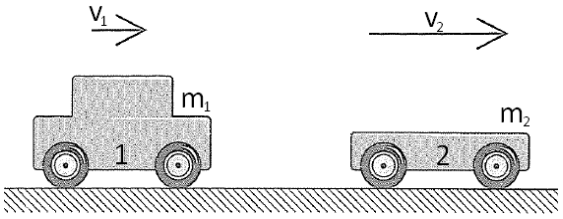
Momentum is measured in kilogram metres per second, kg m/s or kg m s^{-1}

Conservation of momentum

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 a collision or an explosion is the same.



Before

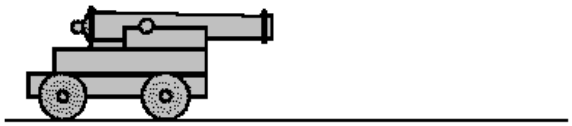


After

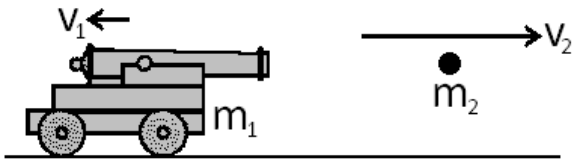
In the situation above, car 1 and car 2 travel to the right with initial velocities u_1 and u_2 respectively. Car 1 catches up to car 2 and they collide. After the collision the cars continue to move to the right but car 1 now travels at velocity v_1 and car 2 travels a velocity v_2. [→ is positive]
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: $0 = m_1 v_1 + m_2 v_2$

But remember, v_1 is negative so: $0 = -m_1 v_1 + m_2 v_2 \quad \rightarrow \quad m_1 v_1 = m_2 v_2$