- A person pushes water backwards during swimming. While swimming we push the water in a backward direction whereas the reaction of water pushes the swimmer in a forward direction.

Newton's 2nd law of motion is the fundamental law of motion (Real law of motion)

Newton's 2nd law is the fundamental (basic) law of motion while the first law and third law are the special cases of the second law.

1. ***Newton's 1st law from 2nd law:***
   According to Newton's 2nd law of motion,

   $F_{net} = ma$

   If, $F_{net} = 0,$ [No net external force]

   Then, $ma = 0$

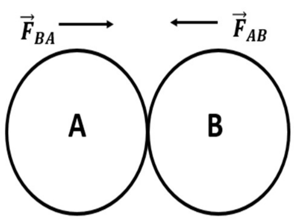
   $\Rightarrow \boldsymbol{a} = \mathbf{0}$ $[m \neq 0]$

   This implies that if no net external force act on the body then,
   a. Either the body is at rest
   b. Or the body is in uniform motion in a straight path.

These two cases explain the first law.

2. ***Newton's 3rd law from 2nd law:***

Consider the collision of two bodies in the absence of external force. (In the collision, one body applies to action and another gives a reaction)



Let, $\vec{F}_{AB}$ = Force on body 'A' due to body 'B'. (Action)
$\vec{F}_{BA}$ = Force on body 'B' due to body 'A'. (Reaction)
Then, the net force acting during the collision,

$$\vec{F}_{net} = \vec{F}_{AB} + \vec{F}_{BA}$$

$$or,\ 0 = \vec{F}_{AB} + \vec{F}_{BA} \quad \text{[Net external force is absent]}$$

$$or,\ \vec{\boldsymbol{F}}_{\boldsymbol{AB}} = -\vec{\boldsymbol{F}}_{\boldsymbol{BA}} \quad ; -ve \text{ sign indicated the opposite direction.}$$

This is Newton's 3rd law of motion.

Principle of conservation of Linear Momentum:

Statement: "If no external force (net force) acts on a system, the total linear momentum of the system always remains constant".

Proof of principle of conservation of momentum using second law of motion. [For SQ]

According to Newton's second law of motion,

$$Force = Rate\ of\ change\ of\ momentum$$

$$F_{net} = \frac{dp}{dt}$$

If $F = 0$, then

$$\frac{dp}{dt} = 0$$

$$or, dp = 0$$

Integrating both the sides, $\int dp = constant$

$$\Rightarrow \boldsymbol{p} = \boldsymbol{constant}$$