Newton's Laws of Motion

Newton's 1st Law

An object will remain at rest, or continue to move with uniform velocity, unless it is acted upon by an external resultant force.

Newton's 2nd Law

The rate of change of an object's linear momentum is directly proportional to the resultant external force. The change in the momentum takes place in the direction of the force.

Newton's 3rd Law

When body A exerts a force on body B, body B exerts an equal but opposite force on body A.

Force is measured in Newtons, N

Applying Newton's Laws

Newton's 1st Law

If the forward and backward forces cancel out, a stationary object will remain stationary.
If the forward forces are greater than the backwards forces, a stationary object will begin to move forwards.
If the forward and backward forces cancel out, a moving object will continue to move with constant velocity.
If the forward forces are greater than the backward forces, a moving object will speed up.
If the backward forces are greater than the forward forces, a moving object will slow down.

Newton's 2nd Law

The acceleration of an object increases when the force is increased but decreases when the mass is increased:

$a = \frac{F}{m}$ but we rearrange this and use $\boxed{F = ma}$

Newton's 3rd Law

Forces are created in pairs.
As you sit on the chair your weight pushes down on the chair, the chair also pushes up against you.
As the chair rests on the floor its weight pushes down on the floor, the floor also pushes up against the chair.
The forces have the same size but opposite directions.

Example – riding on the bus

Newton's 1st Law

You get on a bus and stand up. When the bus is stationary you feel no force, when the bus accelerates you feel a backwards force. You want to stay where you are but the bus forces you to move. When the bus is at a constant speed you feel no forwards or backwards forces. The bus slows down and you feel a forwards force. You want to keep moving at the same speed, but the bus is slowing down so you fall forwards. If the bus turns left you want to keep moving in a straight line so you are forced to the right (in comparison to the bus). If the bus turns right you want to keep moving in a straight line so you are forced left (in comparison to the bus).

Newton's 2nd Law

As more people get on the bus its mass increases, if the driving force of the bus's engine is constant, we can see that it takes longer for the bus to gain speed.

Newton's 3rd Law

As you stand on the bus you are pushing down on the floor with a force that is equal to your weight. If this was the only force acting, you would begin to move through the floor. The floor is exerting a force of equal magnitude but upwards (in the opposite direction).

Example - taking the Lift

Newton's 1st Law

When you get in the lift and when it moves at a constant speed you feel no force up or down. When it sets off going up you feel like you are pushed down, you want to stay where you are. When it sets off going down you feel like you are lighter, you feel pulled up.

Newton's 2nd Law

As more people get in the lift its mass increases, if the lifting force is constant, we can see that it takes longer for the lift to get moving. Or we can see that with more people the greater the lifting force must be.

Newton's 3rd Law

As you stand in the lift you push down on the floor, the floor pushes back.