## 7.5 Lesson- Force and Acceleration.

Newton's Laws (Keys to Understanding Force and Motion)

1. Change of movement needs an unbalanced force
2. The bigger the force the bigger the movement, the bigger the mass the less the movement.
3. For every action there is an equal and opposite reaction.

**Law 1** refers to **Inertia.**
As we learnt in lesson 1, it takes extra force to get an object moving or stop it from moving.
This force is needed **not to just overcome friction** but to get an object moving.

It is particularly true of heavy objects which have a lot of inertia.

**Demonstration Activity : Inertia**
You need:

- a Person to be a pusher/puller
- two people to be riders: small and large person to ride a trolley or skateboard
- a skateboard or trolley or chair with wheels
- a rope about 3 metres.

**Method:**
Put the small student on a skateboard or trolley or chair with wheels.
Give the small person a rope to hold on to.
The Pusher holds the other end of the rope and pushes them.
The Pusher now pulls the rider to stop them.
Feel the strength of forces need to push and pull. You could use a force balance to measure this too.
Now try the larger person on the trolley with the rope.
Compare the push /pull required

Q. What can you say about Inertia and the size of a person?

**Law 2** refers to acceleration (speeding up) and deceleration (slowing down)

There are two rules here:

1. more force = more acceleration or deceleration
2. more mass = less acceleration or deceleration.

**Demonstration Activity : Force and acceleration**

- a Person to be a pusher/puller
- one rider: person to ride a trolley or skateboard
- a skateboard or trolley or chair with wheels
- a rope about 3 metres.

**Method:**

1. Put the person on a skateboard or trolley or chair with wheels. Give the person a rope to hold on to. The Pusher uses only **one hand** to hold the rope and pushes them with the other hand. The Pusher now pulls the with **one hand** on the rider to stop them.

2. This time the pusher uses **both hands** to hold the rope and push the rider and **two hands** to stop them. This is to show increase in force.

Q. What did you notice about the size of force and acceleration?

Q. What did you notice about size of force and deceleration?

*Do Student Investigation 7.6 Investigating Elastic Dragcars*

**Law 3 and Rockets**

Law 3 states that for every action force, there is an equal and opposite reaction force.
So for example if I push on something, it will push me back.
Me pushing is the Action. The Reaction is the object pushing back.
Try pushing a wall while standing on a skateboard.
Q. What happens and why?

Answer:
Action: I push on wall. Wall is too big to move.
Reaction: Wall pushes back on me. I move backwards.

It is not always obvious, but it is always true that forces come in pairs; action and reaction. In fact on earth we have to push off something every time if we want to move.
Q. Can you give examples of this?

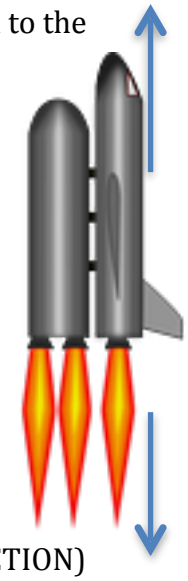
Examples

1. In a race: I push on starting blocks, starting blocks push me forward.
2. I jump: I push on ground, ground pushes me up.
3. I shoot a rifle : The trigger pushes the bullet, the rifle recoils back into my shoulder.

**Rockets use action- reaction forces:**

- A space rocket is a spectacular example of Newton's 3rd law.
- The rocket engine uses the combustion of chemicals to produce exhaust gases. The high pressures and temperatures of combustion are used to accelerate the exhaust gases through a rocket nozzle out the back.
- The reaction to the acceleration of the gases produces the forward thrust of the rocket. The exhaust gases are expelled from the engine in one

direction (ACTION) and the thrust force is applied to the engine in the opposite direction (REACTION)



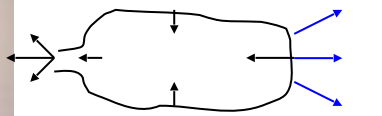
Thrust – Reaction force

Exhaust – Action force

## Rockets and Cars move differently

- Cars need the ground to move (Push the ground (ACTION) and the ground pushes back (Reaction)
- Rockets throw things out (gases or liquids) to move (action – gas pushed out, reaction -rocket goes forward)
- Rockets don't need a platform to push against, because they are ejecting gases which cause the motion. This can happen anywhere including out in space! Otherwise how would they get back to earth?

### The Balloon Rocket




- Balloon propulsion does differ from rocket propulsion in that the air particles are squeezed out of a balloon by the contracting balloon rubber, whereas in a rocket the gas is exhausted as a result of the rapid expansion of the very hot particles. Nevertheless, it is exhaustion of the gas from the opening that is the action force in both cases. In terms of Newton's Third Law of Motion, the reaction is the balloon moving away from the opening.

***Do Investigation 7.7 Investigating Balloon Rockets***