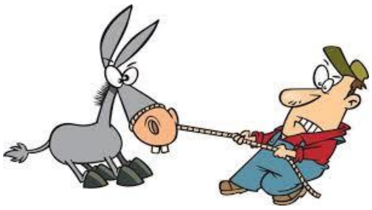
UNIT 3

FORCES AND THEIR EFFECTS.



KEY CONCEPTS

- Forces are interactions between bodies that cause changes.
- The newton (N) is the unit for force in the SI system.
- Forces are represented by arrows.
- The force that acts on a body is directly proportional to its acceleration.
- Forces are measured with the dynamometer.

1. WHAT ARE FORCES?

We use the word ***force*** every day in lots of situations. You will probably will heard phrases like "May the force be with you!" or "You can't force me to do it". However, as many other words, the meaning of this word in physics is different from how we use it in our everyday lives.

If you push your desk, it will move; if you *squeeze* your rubber, you will deform it for a few seconds (or even break if you squeeze it very hard). In both these examples, the body has *undergo* some kind of change just by applying force to them.

For a force to exist, there must be some kind of interaction between two or more bodies. So forces causes an object to change its shape, its direction or its speed.

A **force** is a physical agent that can deform an object or change its state of rest or of motion.

1.1. Types of forces.

To move a bed, you put your hands on it and push. However, a magnet will attract a piece of iron without being in contact with it. In both cases, we are talking about forces – the two types of forces that exist in nature:

- **Contact forces:** these are directly applied on an object. For example when we push a bed to move it.
- **Non-contact forces:** these act from a distance and there is no physical contact between the objects. For example, when a magnet attracts a piece of iron.

1.2. Units of force.

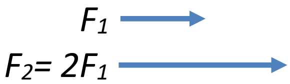
The unit of force in the International System of Units (SI) is the **newton**, represented by the letter **N**. It is named after the English physicist Sir Isaac Newton.

1.3. How forces are represented.

If someone asks you to push your desk, you will probably need more information. You need to know how hard to push it, in which direction or even when on the desk you should apply the force.

With forces, like many other quantities, it is not enough to know the numerical value of this quantity and its unit, we also need to know the direction of motion of the force.

One way of visually representing these types of quantities is by using **arrows** that indicate the direction of motion. The length of the arrow is proportional to its value.



2. FORCES AND MOTION

We can find many solid objects all around us. If we push or pull an object, it may be deformed (change its shape) permanently, like plasticine or modelling clay (**plastic materials**) or not, like a spring or a hairband (**elastic materials**).

However, we can find many other objects that do not deform no matter how much force we apply to them, like rocks and bricks. They are called **non-malleable** or **rigid solids**.

If you push a table (a rigid solid), you apply a force to it. Then, the table will move starting from a stationary position, changes its position and gains acceleration. In the same way, several forces can act on a body at the same time.

If a **single force** is applied to a **stationary body** or the sum of the forces acting on it is not zero, the body will **accelerate**.

If we apply a force or several forces to a moving object, this will change its state of motion. Depending on the forces and the direction of these forces, the speed of the object may increase or decrease (or even stop) or the object may change its direction.

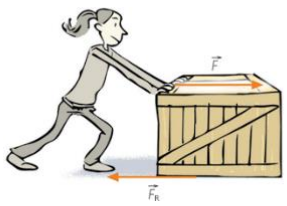
If a **force** acts on a **body in motion** or if the sum of the forces acting on it is not zero, it will change its motion (it will have **acceleration**).

2.1. Newton's Laws of Motion

Sir Isaac Newton (a 17th century scientist) studied the relationships between forces and motion and tried to explain why objects move (or don't move) as they do. Newton put forth three laws which have become known as Newton's three laws of motion.

Newton's First Law: An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon an external force.

This is known too as the **Law of inertia** and all we have experimented it in our everyday life.



If you try to move a desk and try it again with the drawers full, the mass will be greater so you will have to exert greater force to make it move (that is, to make it accelerate). Newton proposed the relationship between these three quantities (mass, acceleration and force) with his **Second Law of Motion:**

The **force (F)** acting on a body is directly proportional to the **acceleration (a)** of the body, where the **mass (m)** is the proportionality constant.

$$\boldsymbol{F = m \times a}$$

2.2. Force measurement

Once studied Newton's Second Law of Motion, we can define what the SI unit of force, a newton, is:

A **newton** (1 N) is the force that causes a body with a mass of one kilogram (1 kg) to accelerate by one metre per second squared (1 m/s^2).

We use a **dynamometer** to measure forces. It consists of a spring which stretches when a force is applied to it. The dynamometer is calibrated to find the relationship between the extension and force. It gives us a reading of the force applied, usually given in newtons.