Physics Knowledge Organiser
Forces

KPI 10.1: Use diagrams with correctly labelled force arrows to display a range of forces in different situations.

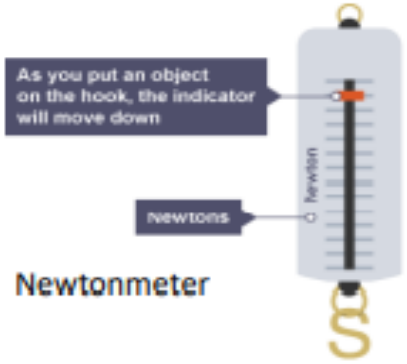
A force can be a **push or a pull.** You can not see forces, you can only see what the changes to objects that they cause.

When a force is applied to an object it can lead to:
- **A change in speed (acceleration)**
- **A change in the object's direction of movement**
- **A change in the object's shape (squash or stretch the object).**

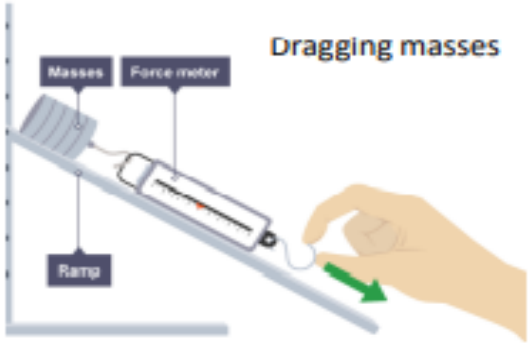
Forces can also be divided into 2 types, contact forces and non contact forces.

1. **Contact forces** act between objects that are touching. Examples: friction, normal contact force, thrust, upthrust, air resistance (drag). Friction acts whenever an object is moving through a fluid (a fluid is a liquid or gas), or when one solid surface is moving along another solid surface.
2. **Non-contact forces** act between objects even if they are NOT touching. Examples: gravity, weight, magnetic force.

The unit of force is the **newton (N).** This is named after Sir Isaac Newton, who developed a theory of gravity and showed how forces affect objects.



Newtonmeter



Dragging masses

Key Terms	Definitions
force	An interaction between objects that causes **changes** to objects or how objects are moving.
newton	The unit for force
newtonmeter	A piece of equipment that can be used to measure the size of the force
contact force	A force acting between objects that are physically touching
non-contact force	A force acting between objects that are NOT physically touching
weight	The force pulling an object towards the centre of the Earth, due to gravity.
gravity	The force between any two objects. We only notice gravity's pull if the objects are very large, like the Earth.
upthrust	The upwards force produced by objects pushing down on fluids (liquids and gases).
normal contact force	The push force produced on objects when they push on something solid. Also called 'reaction'.

Measuring the size of forces

The laboratory equipment for measuring forces is also named after Sir Isaac Newton: the newtonmeter (see diagram).

To measure the size of frictional forces on different surfaces you can drag masses along the different surfaces and record how much force is required. For this experiment :
- Independent variable: Type of surface
- Dependent variable: Force
- Control variable: Mass

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KPI 10.2: Interpret force diagrams to determine the motion of an object.

Force Arrows

Forces have a **size** and a **direction**. This means we show forces with arrows.

- The length of the arrows shows how large the force is.
- The direction the arrow points shows the direction the force pushes or pulls.

Diagrams that show the forces acting on objects, using arrows, are called **free body force diagrams**.

Resultant force

The **resultant** force acting on an object is the single force *resulting* from all the separate forces acting on it. In other words, the resultant force is the single overall force.

To find resultant force:

- Add up forces acting in the same direction
- Subtract forces acting in opposite directions.

If the forces are equal in size and opposite in direction, the forces are **balanced** and the resultant force is 0 N. In all the free body force diagrams to the right, the forces are balanced. If the forces are not equal in size, they are **unbalanced** and the resultant force is NOT 0 N.

Resultant forces cause the **changes** to objects described on the last page.

We will focus on changes to speed:

1. If the resultant force on an object is 0 N, the object's speed does not change. This means it is stationary (still) OR keeps going at a constant speed.
2. If there is a resultant force on an object, its speed will change. It will **accelerate** or **decelerate**.
3. Knowing the resultant force does not tell you which way an object is moving. It just tells you that the speed will change.
4. A LARGER resultant force is needed to accelerate an object at a higher acceleration. Also, a larger resultant force is needed to accelerate heavier objects.

Newton's second law

Point 4. above is shown in Newton's second law: this equation –

$$F_R = m \times a$$

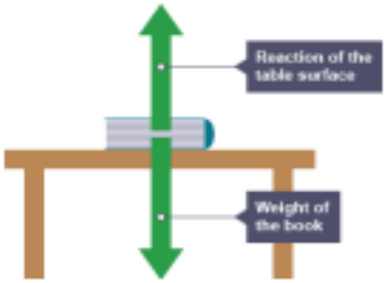
Where F_R is the **resultant force** measured in newtons,
m is the **mass** of the object measured in kilograms,
a is the **acceleration** of the object measured in metres per second per second (m/s/s).

Free Body Force Diagrams

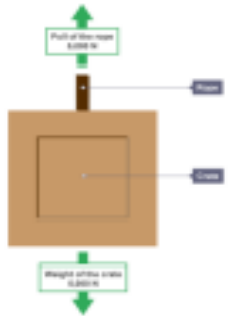
Learn the forces and their directions for each force on these free body force diagrams:

A boat floating

A book on a desk



A crate held up by a rope



Forces and Energy

When forces are acting on an object, it causes a transfer in the store of energy.

Example to know: when a push force is applied to a moving object, the energy changes store from kinetic energy to thermal energy. This is because the push force is working against friction, and friction causes objects to warm up.