Forces

You must be able to:

- Calculate the net force or resultant force acting on an object when it experiences more than one force (acting along the same line)
- Understand that when two objects have force between them, they both experience force, and the forces are the same size but in opposite directions
- Recall that acceleration is not possible without net force, and a net force always produces acceleration.

Contact Force

- You can push and pull objects by making contact with them.
- The force you apply can be partly or completely a force of **friction.**
- Friction acts parallel to the surface of the object.
- You can also push at right-angles to the object. This is called a **normal force.**
- Force is measured in newtons, N.

Key Point

Force is a vector quantity – direction matters. Arrows can be drawn to show force.

Non-Contact Force

- Two magnets can attract or **repel** each other without touching.
- Electric force also acts without contact (without touching).
- Gravity provides another force that can act at a distance.

Gravitational and Electric Force

- All objects that have mass experience gravitational force.
- All objects with electric charge experience electric force.
- Gravitational force is always attractive, so there must be only one kind of mass.
- The Earth attracts you. The force, measured in N, is your weight.
- Electric force can be attractive or repulsive, so there must be two kinds of electric charge – positive and negative.

Net Force

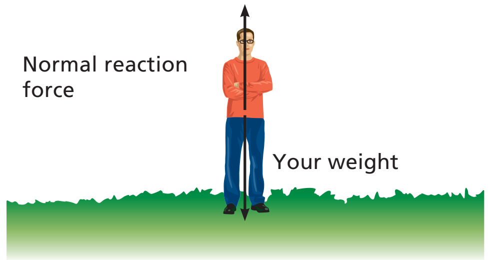
- The overall force for a combination of forces is called their **resultant force** or **net force.**
- When there is a net force on an object it *always* accelerates.
- When there is no force at all on an object or the forces are balanced, it *never* accelerates. (It can move, but the motion never changes.)
- A body stays still or keeps moving at constant velocity unless an **external force** acts on it. That idea is called **Newton's first law.**

Key Point

If net force is not zero, the forces are unbalanced and there is acceleration. If motion is steady and in a straight line, velocity is constant and there is no acceleration.

Direction of Force

- The direction of a force makes a big difference to the effect it has.
  - Forces in different directions have different effects.
  - Forces of different sizes have different effects.
  - Two forces of the same size acting in opposite directions do *not* cause acceleration, so the net force is zero.
  - Two forces acting in the same direction add together to produce a bigger net force.



Equal but Opposite Forces

Acceleration is zero, but the object can have velocity.

- When you push an object, such as a table, you experience a force of the same size and in the opposite direction.
- **Newton's third law** states that for every force there is an equal and opposite force.
- For example, a spacecraft can accelerate (or decelerate) by pushing gases (made by burning fuel) away from itself.
- When you stand on the floor: - your your weight acts as a force on the floor
  - the floor provides an equal force in the opposite direction - this is called a normal reaction force.

Force and Acceleration

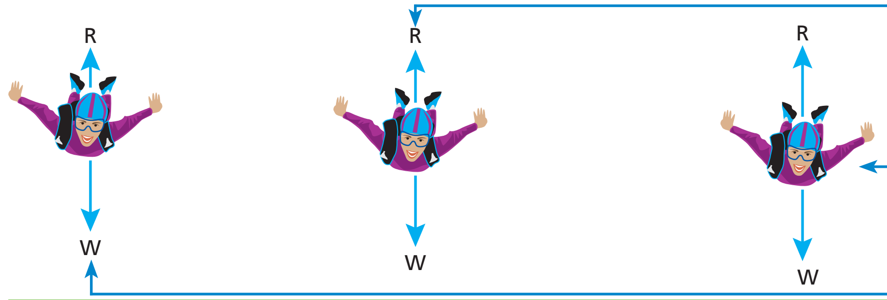
- Net force is related to acceleration in a fairly simple way:
  - acceleration is bigger when force is bigger
  - but smaller when mass is bigger.

LEARN: **force (N) = mass (kg) × acceleration (m/s²)**

- These equations are related to **Newton's second law.**

HT Resistive Force on a Falling Object

- Air resistance creates a **resistive force** opposite to the force of gravity.
- The faster an object falls, the bigger the resistive force.
- Eventually the upwards resistive force becomes as big as the downwards gravitational force.
- The two forces are equal and opposite, so there is no net force.
- When there is no net force there is no acceleration, so a falling object continues to fall at constant velocity.
- That velocity is called the object's **terminal velocity.**



Eventually, the velocity is so large that resistive force is the same size as the weight. Net force is zero. So acceleration is zero. Velocity stays the same.

As velocity increases, resisitive force increases. But there is still a net downwards force so the sky-diver continues to gain velocity.

At first velocity is small so resistive force is small. There is a large net force acting downwards. The sky-diver accelerates downwards.

Quick Test

1. Name the kind of force that keeps you in your seat.
2. Name the kind of force that holds your body together.
3. State what is necessary , in terms of forces, for acceleration to happen.
4. When a ball is dropped, the effect of air resistance is ignored because it is too small. Explain why a skydiver, who jumps from a plane, cannot ignore the effect of air resistance.

Key Words

friction
normal force
repel
Newton's third law
resultant force
net force
external force
Newton's first law
Newton's second law
resistive force
terminal velocity