

# UNIT 5.3

## Newton's First Law

### Context

Forces act on us every day, causing many different effects. How do these forces act and what is the interaction between them? In 1687, Isaac Newton asked the same question. He then formulated three laws to explain how objects move when a force acts on them. They are often referred to as Newton's Laws.

### What is a force?

A **force** is a push, pull or twist that causes an object to either:

- increase its speed (accelerate)
- decrease its speed (decelerate)
- change its direction, or
- change its shape.

If any of these things happen, then a force caused it.

### Newton's First Law

Newton's First Law examines the forces on an object that is:

- at rest
- in motion.

#### No force and not moving

Place a pen on the desk. Watch what it is doing. Of course, it's not moving. This effect is called **inertia**. Sir Isaac Newton described it in his **First Law**.

Newton's First Law states:

**Anything at rest will stay that way unless pushed or pulled.**

That is, a force is required to get something moving.

#### No force but still moving

Why do you wear seatbelts in a moving car? If you answered, 'Because you are thrown forward in a car accident', then you're wrong! This suggests that something pushed you ... the seat must have shoved you so hard in the back that you were flung towards the windscreen! This is of course ridiculous: it implies that seats are capable of throwing you

around whenever they like! In an accident, you don't get thrown forward: the car stops moving but you keep moving like you were before—until you hit something, like the windscreen, dash or steering wheel, which will provide a stopping (and injuring) force. This continued movement is called inertia, too.

### Physics facts

#### Types of forces

The force you apply is very obvious when you physically push or pull something. This is an obvious contact force. A summary of other forces that you will have met before is given below. Some will be discussed in this chapter.

#### Contact forces

- *Friction*: acts between any two surfaces that try and slide over one another. Acts in the opposite direction to the movement or attempted movement.
- *Air resistance and drag*: friction of air (or liquid or other gases) as it travels across a moving object. Like friction, it acts in a direction opposite to the movement.
- *Buoyancy*: 'floating' force. Acts upwards, opposing the weight force.
- *Surface tension*: tiny forces between particles on the surface of a liquid that form a 'skin' on the liquid.
- *Lift*: caused by air moving over a wing or airfoil. Acts at  $90^\circ$  to the surface of the airfoil.
- *Thrust*: caused by gases or liquid being pushed out the rear of an engine, jet or rocket.

#### Non-contact forces

- *Weight*: caused by gravity. Acts 'downwards', towards the centre of the planet.
- *Electrostatic*: repulsion of like charges (+/+ or -/-) or attraction of unlike charges (+/-).
- *Magnetic*: repulsion of like poles (N/N or S/S) or attraction of unlike poles (N/S).

### Science Focus

#### Deadly dogs

In accidents, an unrestrained family dog becomes a projectile and can potentially kill or injure anyone in the seating area. Most dogs range from 10 to 50 kg and will not be prepared for the accident when it happens, losing their balance and flying forward, with disastrous results.