

## NEWTON'S LAWS OF MOTION

### Objectives

After studying this section, you should be able to:

1. Define or explain the meaning of the following terms:
  - action-reaction forces
  - force
  - inertia
  - mass
  - newton
  - weight
2. State Newton's three laws of motion and give everyday examples of their application.
3. Calculate forces or accelerations using Newton's second law, given the appropriate data.
4. Distinguish between weight and mass and calculate the gravitational force on a given mass.

### Introduction

On Christmas Day of 1642, the same year that Galileo died, Isaac Newton was born to a farming family in Lincolnshire. Driven from his studies at Cambridge by the Great Plague in 1665, Newton returned to his family farm. There, at the age of 23, he formulated the laws which became the foundations of mechanics.

Newton's predecessors – Galileo, Descartes, Huygens and others – had described the motion of bodies in terms of such measurable quantities as velocity, acceleration and momentum, and they had demonstrated how these quantities are mathematically related.

But what caused bodies to move in the first place? And what is the relation between that which causes a body to move and the subsequent motion of the body, as expressed in terms of velocity, acceleration and momentum? It was these questions that Newton set himself to answer.

#### Newton's first law

Before Newton, the state of rest was regarded as the 'natural' state of all bodies. This seemed obvious: if you didn't pull, shove, push or drag something, it did not move; it simply stayed where it was. If the state of rest was natural, motion was, therefore, an 'unnatural' deviation from this universal norm.

For example, consider pushing a car from rest. If the car is to move, the force of your push must exceed the inertia of the stationary car. All bodies possess this built-in property called **inertia**, which is their resistance to being moved by applied forces.