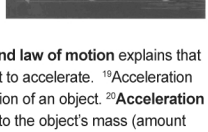
7—Force and Motion

A [1]You may associate Sir Isaac Newton with an apple falling from a tree. [2]His book, Principia, published in 1686, was about much more. [3]In this book he combined his ideas on the motion of objects with the ideas of many other scientists. [4]A **force** is a push or a pull that has size and direction. [5]The force of wind can push a piece of paper. [6]Force can be applied by your arms to pull a rope. [7]**Friction** is the force that resists the movement of one surface past another. [8]**Kinetic friction**, sometimes referred to as "sliding friction", opposes the motion of a moving body. [9]Sledding or skiing down a snowy hill is an example of kinetic friction. [10]**Static friction** opposes movement from a resting position, so there is no movement.

B [11]**Newton's first law of motion** is also known as the law of inertia. [12]The law of **inertia** states that unless a force is applied, an object in motion continues to move with a constant **velocity** (speed and direction), while a motionless object remains still. [13]A soccer ball that is sitting still will remain that way until a force of some type moves it, such as your foot kicking it. [14]The ball will continue to move until it encounters a force that changes its velocity, such as the friction against the ground or the force of hitting the soccer net. [15]Inertia is the reason you need to wear your seatbelt while riding in a car. [16]The force of a car's brakes being applied changes its velocity. [17]When the car brakes quickly, your body's inertia continues to move at the speed the car had been traveling before braking, causing you to feel like you get thrown forward.

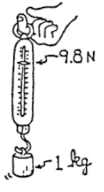


C [18]**Newton's second law of motion** explains that force causes an object to accelerate. [19]Acceleration is a change in the motion of an object. [20]**Acceleration** of an object is related to the object's mass (amount of matter) and to the amount of force applied to the object. [21]Objects with a greater mass have less acceleration and objects given a greater force have greater acceleration. [22]If a box of books is too heavy for you to move, you could reduce the mass by removing some of the books or increase the force by asking for someone else to help you move the box.

D [23]**Newton's third law of motion** explains action and reaction. [24]When force is applied to an object, the object exerts an equal force in the opposite direction. [25]The reaction of a basketball against the ground is one way to understand this force. [26]The basketball exerts force on the ground and the ground exerts force on the ball. [27]Once the action of stepping forward is complete, what will be the reaction of the skateboard?

E [28]Isaac Newton also explained laws of momentum. [29]**Momentum** is the quantity that measures both the mass of an object and how fast the object is moving. [30]A large truck has more momentum than a small car that is moving at the same speed because the truck has more mass. [31]However, the car can have more momentum than the truck if the car is moving at a great enough speed.

F [32]**Gravitational force** is the force of attraction between any two objects in the universe. [33]Isaac Newton explained that the gravitational force is greater between objects with larger masses. [34]He also explained that this force increases as objects move closer to each other. [35]You can measure the gravitational force of the earth on an object by weighing it. [36]This is known as the object's **weight**. [37]Force can be measured in metric units called **Newtons** (N). [38]One Newton is the force needed to change the speed of a one-kilogram object by one meter per second each second. [39]It takes about the force of one Newton to lift a deck of cards. [40]A **spring scale** is used to measure force. [41]The measurement of weight would decrease at places where there is less gravity, such as the moon. [42]Study the diagram to see how a spring scale is used to measure the force of 1 kilogram.



Why do you think the unit of force is called a Newton?