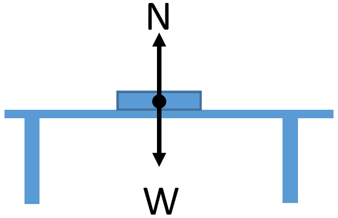
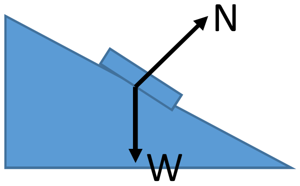
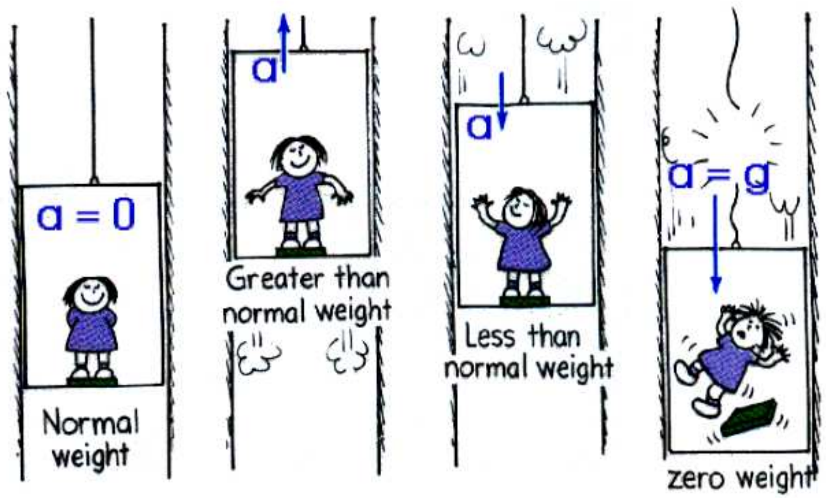
Normal force

The normal force F_N is a perpendicular force exerted by a surface on the object in contact with the surface. An object resting on a table for instance exerts a force equal to its weight on the surface of the table. By Newton's third law, the table exerts an equal and opposite force on the object.





When a person stands on a scale, the reading on the scale is actually the Normal Force that the scale exerts back towards the person to support the person's weight.



Normal force

Example 3.4: Weight and the normal force in an elevator

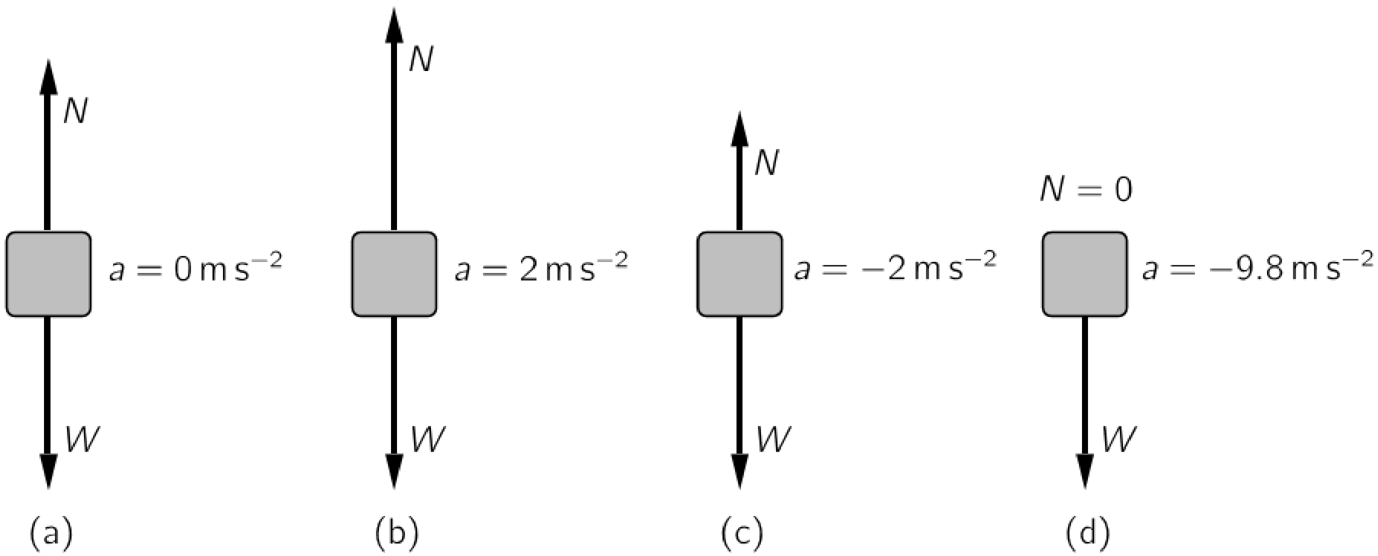
Find the apparent weight of a person whose mass is 60 kg in an elevator, when the elevator

(a) is stationary,

(b) accelerating upward at 2 ms^{-2} ,

(c) accelerating downward at 2 ms^{-2} , and

(d) in free-fall.



Friction

Friction is the force that opposes the motion of one surface moving over another, with which it is in contact. Its magnitude depends on the materials of which the two surfaces are made, as well as on the force pressing them together. The friction has positive as well as negatives effects.

- For example, in the machines, friction causes a loss of energy in a for of heat. Moreover, the liberated heat may cause damage to the machines itself.
- On the other hand, is useful as it make walking possible.

There are three types of friction forces

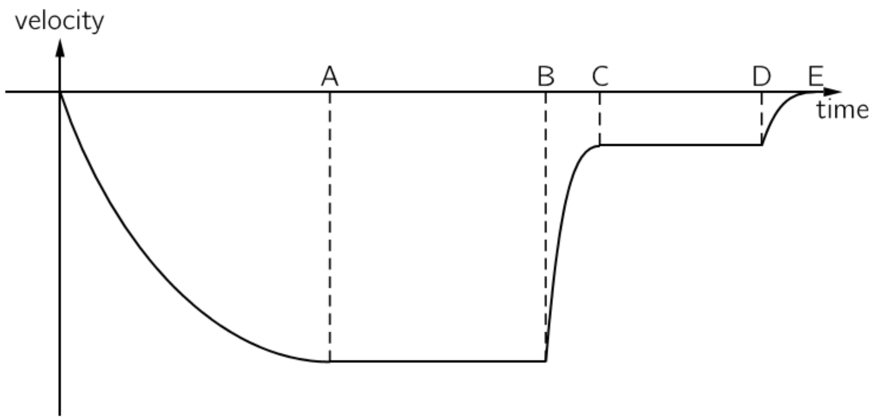
- Static friction,
- Dynamic or kinetic friction and
- Rolling friction

Friction force also exist when an object is falling through a medium, e.g. fluid. An important example which involve Newton’s first law is the case of an object falling through air e.g. a skydiver.

Friction cont.

Example 3.5: Velocity time graph for a skydiver

A skydiver jumps from an aeroplane. Sketch a velocity–time graph for the vertical motion of the skydiver indicating where the skydiver reaches terminal velocity, opens her parachute and lands.



Tension

Tension is force exerted on the string. When the force is exerted on the string, force is transmitted through the string.

Application of Newton’s laws

In this section we consider the application of Newton’s law. We will first consider application on objects which are **at rest i.e. equilibrium system** and when objects are **accelerating i.e. non-equilibrium system.**

Guidelines for solving problems involving Newton’s laws

The following points must be remembered when the relationship F = ma is used:

1. The mass in Newton’s second law (F = ma) represents the **total mass** accelerated by the **net force**.
2. F represents the **net force in the direction of motion**. If the accelerated mass is acted upon by a number of forces, the total net component of the forces in the direction of the motion must be calculated.

Method for solving

1. Draw a diagram representing the general situation.
2. Select one object from the situation whose motion is to be analysed and draw a free- body diagram for this object.
3. Select a convenient origin and orientation of the coordinate axes.
4. Write an expression for the net force.
5. Apply Newton’s second law.

Application of Newton's laws-Equilibrium application

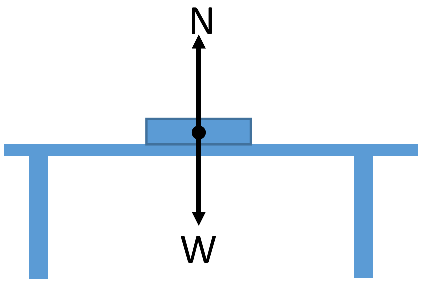
- An object is in equilibrium when it has zero acceleration.
- When the acceleration of an object is zero, the net force on the object is zero by Newton's first law.
- Thus when an object is in equilibrium in two dimensions, we must have

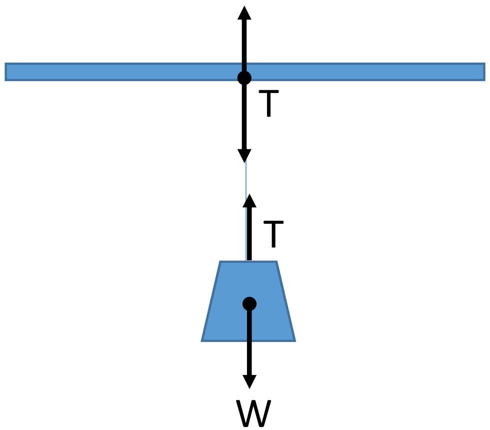
$$\sum F_x = 0$$

$$\sum F_y = 0$$

Examples of systems in equilibrium include

- a book lying on a table,
- a lamp hanging from a cord or
- a vehicle moving at constant velocity.





Application of Newton's laws-Equilibrium application

Example 3.6: Tension in a cord, one dimension (equilibrium case)

A lamp is suspended from the ceiling by a cord. If the lamp has a mass of 5 kg, determine the tension in the cord.

Example 3.7: Tension in a cord, two dimensions (equilibrium case)

A lamp is suspended by three cords as depicted in the diagram below. The cord attached to the ceiling makes an angle of 60^o with the ceiling and the cord attached to the wall is stretched horizontally. If the lamp has a mass of 5 kg, determine the tensions in the cords.