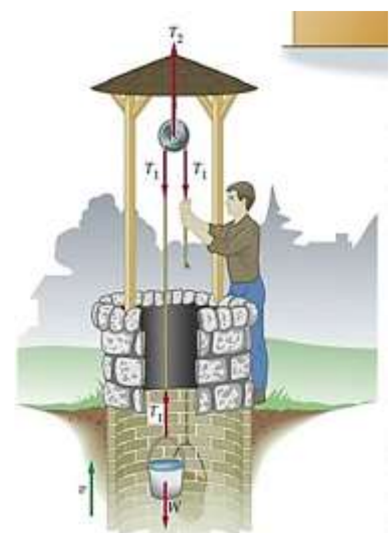
DIFFERENT TYPES OF FORCES



DIFFERENT TYPES OF FORCES

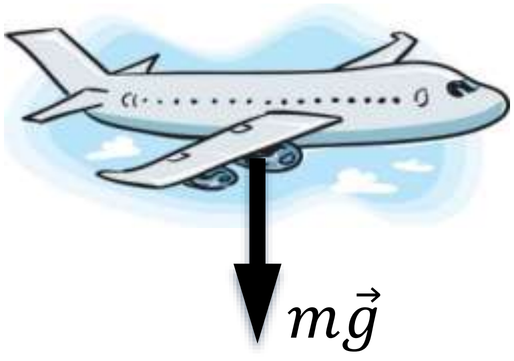
►GRAVITY FORCE

The force of gravity is the force with which the earth, moon, or other massively large object attracts another object towards itself. All objects upon earth experience a force of gravity that is directed "downward" towards the center of the earth.

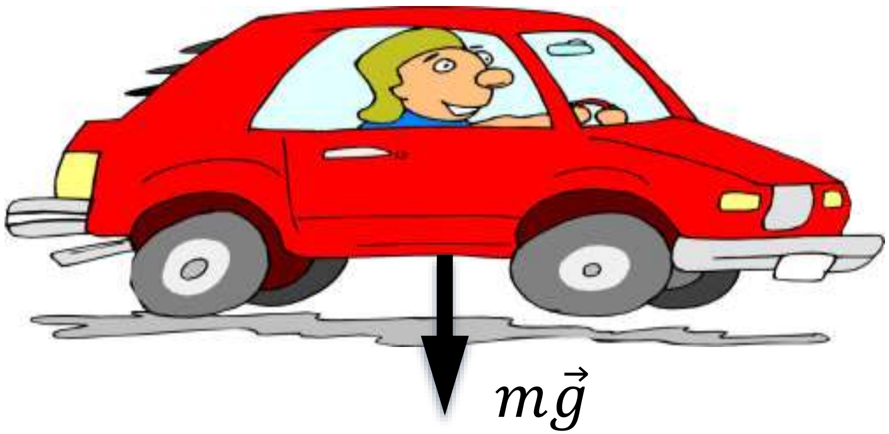
The force of gravity on earth is always equal to the weight of the object as found by the equation:

$$\vec{F}_g = m \cdot \vec{g}$$

- m is the mass of the body measured in kilograms
- g is acceleration due to gravity. (g=9,81 $N \cdot kg^{-1}$, number that will often approximate by the more convenient 10 $N \cdot kg^{-1}$). Its units are newton per kilogram ($N \cdot kg^{-1}$) or ($m \cdot s^{-2}$).



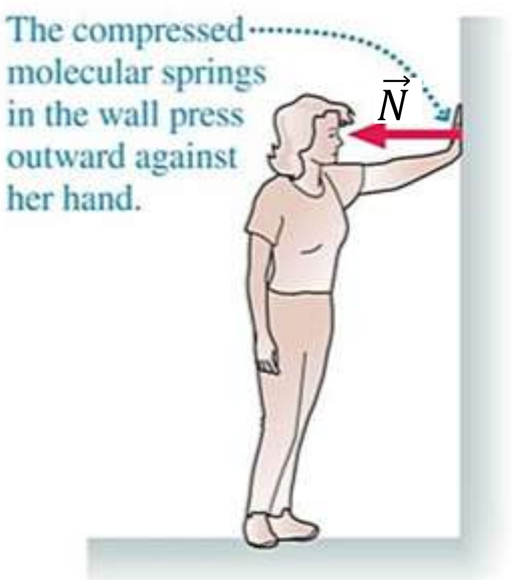
This force is always directed vertically downward

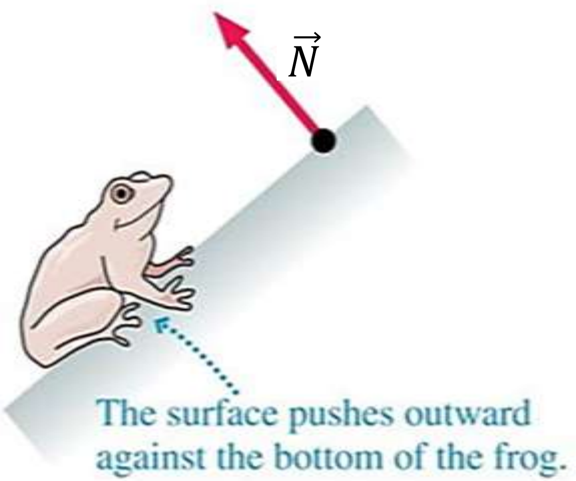


► NORMAL REACTION (CONTACT) FORCE

If you stand on a mattress. Earth pulls you downward, but you remain stationary. The reason is that the mattress, because it deforms downward due to you, pushes up on you. Similarly, if you stand on a floor. it deforms (it is compressed. bend. or buckled ever so slightly) and pushes up on you. Even a seemingly rigid concrete floor does this (if it is not sitting directly on the ground, enough people on the floor could break it).

The push on you from the mattress or floor is a normal force ($\vec{F}_N$ or $\vec{N}$). The name comes from the mathematical term normal. meaning perpendicular. The force on you from say, the force is perpendicular to the floor. When a body presses against a surface. the surface (even a seemingly rigid one) deforms, and pushes on the body with a normal force $\vec{F}_N$ or $\vec{N}$ that is perpendicular to the surface.



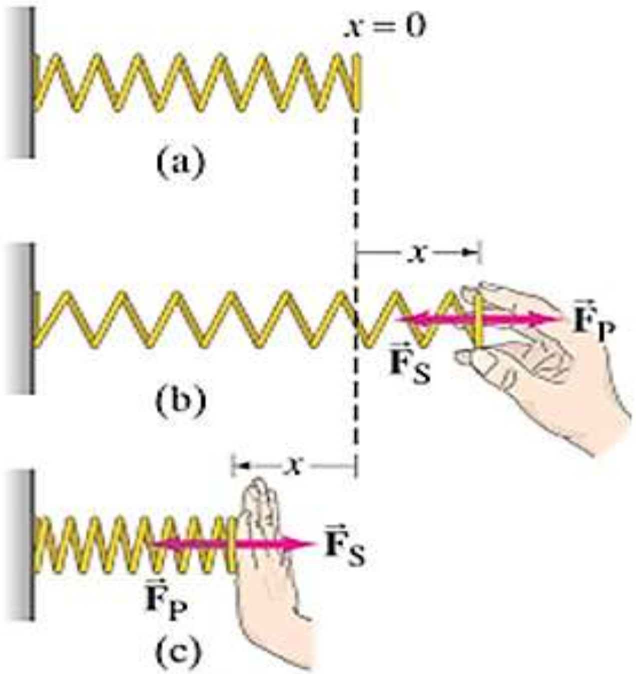


Suppose you place your hand on a wall and lean against it. The wall exerts a horizonal normal force on your hand.

Suppose a frog sits on an inclined surface. The surface exerts a titled normal force on the frog.

►ELASTIC FORCE. HOOK'S LAW

When we compress or extend a stretched spring, we experience a force equal to that applied by us in the opposite direction. Have you wondered why this happens? When a spring deviates from its mean position, it tends to restore its equilibrium by exerting a force equal and opposite to the external force.



Let us consider a spring fixed to a rigid wall as shown in picture;

- You can see that if the spring isn't stretched or compressed, it exerts no forces (picture a).
- If we try to extend a spring ($\vec{F}_p$), a elastic force ($\vec{F}_s$) pulls the spring back to its original length (picture b).
- If we try to compress a spring ($\vec{F}_p$), again a elastic force ($\vec{F}_s$) tries to pull the spring back to its original length (picture c).

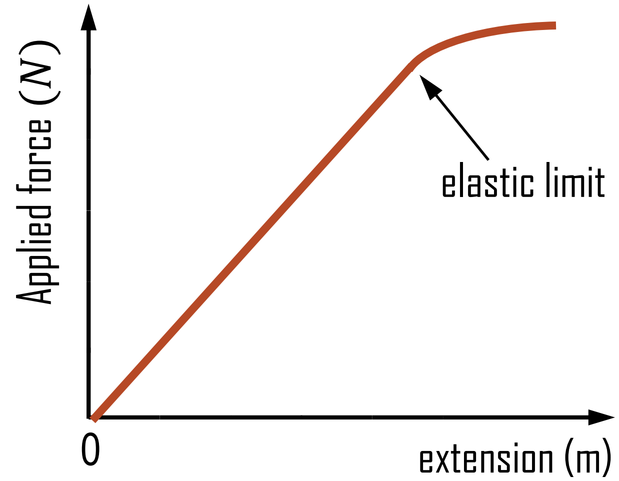
This elastic force is called restoring force and it always acts to restore the spring toward equilibrium (the spring exerts its force in the direction opposite to the displacement).

The elastic force (F_s) in the spring, has a relationship to the amount by which the spring is extended or compressed. If this amount is x then the elastic force is proportional to x. This mean that the more we want to extand or compress the spring, the bigger the elastic force required to pull or push it with.

In equation form it says that $\boldsymbol{F_s = k \cdot x}$ where x is the distance the spring is stretched or compressed away from its equilibrium or rest position; k is constant of proportionally (spring constant) and it depends on the material spring, but also depends on the dimensions of the spring. Spring constant has a unit N/m.
This equation $\boldsymbol{F_s = k \cdot x}$ is known as the **spring equation** or **Hooke's Law**.

Graph representing the relation between the applied Force in Newtons and the extension of the stretched spring in meters. The applied force versus extension graph forms a diagonal line that passes through the origin. The slope of the diagonal line corresponds to the spring constant k. The graph provides a diagonal line assuming the elastic limit has not been reached (This means, that the spring after stretching or compressing can still come back to its original shape).

If the sample, after stretching or compressing cannot go back to its original form, it means it has lost it properties of elasticity and shows the plastic behavior, It is beyond the elastic limit.



'Do stop pulling the cat's tail, darling.'
'I'm not pulling, Mummy, Pussy's pulling".

Fun story of the Hooke's law

It is generally fairly easy to see why a load pushes or pulls on a object.

The difficulty is to see why the object should push or pull back at the load.

If we are talking about living creatures we can imagine that cat uses its muscles trying to yank its tail free. This is why it "generates" force that is opposite to girls pull on its tail. Since both forces are equal there is equilibrium and neither girl nor cat moves (the cat is not happy about that!).

Finally, however, Hooke concluded:

The power of any Spring is in the same proportion with the Extension thereof!

From there it was quite easy to sum it into a shorter sentence:

As the extension, so the force.

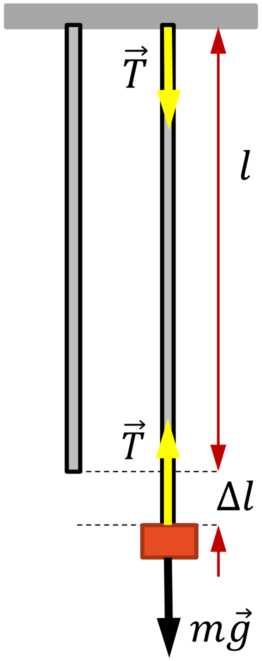
▶ TENSION FORCE. HOOK'S LAW

Let's consider the tension of wires, bars and rods. The length of rod (wire, bar) is much greater than the width or thickness. An object (wire, bar and rod) exerted by force, such as pulling force will cause the length of the change. If the amount of elongation Δl is small compare to the length l of the object then:

Hooke's Law state that:
The change in length is proportional to the applied force $F = k \cdot \Delta l$

F is applied force (or weight mg) pulling on the object,
Δl is deformation (where Δl is the change in length of the wire, bar and rod)
and k is coefficient of elasticity

This means if you double the applied force its elogation will double, if you triple the applied force the elongation will triple and so on. The elastic constant k is a measure of the elasticity of the wire, bar and rod. The coefficient of elasticity depends on the material body, but also depends on the dimensions of the body.



The **tension force T** is the force that is transmitted through a rod or (wire, bar) when it is pulled tight by forces actings from opposite ends. The force exerted by the one end of the rod, (or wire, bar) is opposite and equal to the force exerted by the other end of the rod, or (wire, bar); both forces must be parallel to the rod or (wire, bar) and pointed towards its center. The tension is the same everywhere, and its direction is such that it always pulls away from the body on which it acts. In the case of the hanging body, the rod pulls it up, so the rod exerts an upward force on the body, and the tension will be upwards.

The tension in the rod is equal to the weight of the body hanging from it when the object is in equilibrium.

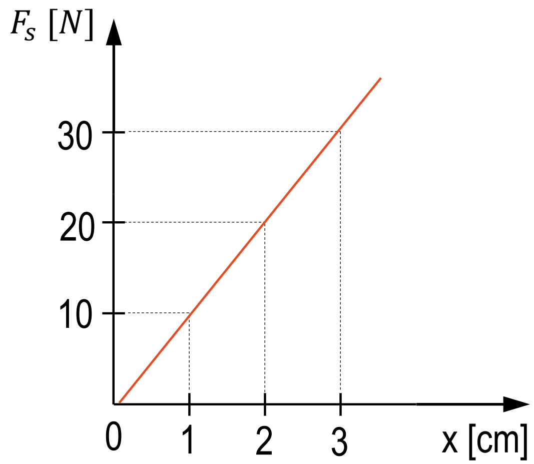
$$\boldsymbol{T = mg}$$

PROBLEMS

1.An iron cube has side of 2,5cm. Find the gravty force and normal reaction force that acts on cube ? Density of iron is 7800 kg/m^3.Draw a picture.

2. In physics, a tilted surface is called an inclined plane. Objects are known to accelerate down inclined planes because of an unbalanced force. To understand this type of motion, it is important to analyze the forces acting upon an object on an inclined plane. A 60kg body slides down a frictionless incline plane with slope 30º. Draw all forces that act on a body and resolve gravity force into its parallel and normal components?

3. A mass of 125g is attached to a spring of spring constant k=58N/m that is hanging vertically.
   a) Find the extention of the spring
   b) If the mass and spring are placed on the moon, will there be any change in the extension of the spring?



4. Graph shows elastic force in spring as a function of spring extension.
   a) Find the spring constant
   b) If a mass of 25kg is attached to a spring. Find the extension of the spring.