INTRODUCTION TO FORCES

WHAT IS A FORCE?

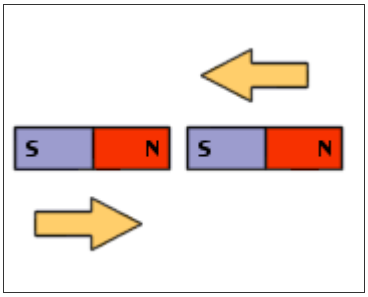
A force is a push or a pull. It is measured in Newtons (N). Forces act in pairs and they always act in a certain direction. Forces can't be seen, but their effects can.

Forces can cause a still object to move or cause a moving object to move faster. If the forces acting on an object are balanced, the velocity is constant. If the object is accelerating, the forces acting on it are unbalanced. Bigger forces make bigger accelerations. Larger masses need larger forces to produce the same acceleration.

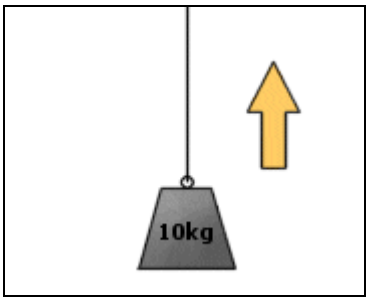
Generally speaking, a force will act in a particular direction. A force is changed if either its size or its direction is changed.

When no force is acting on an object it will remain stationary. Or, if it was moving, it will carry on in the same direction at the same speed. It will also remain stationary if the forces on an object are equal in size and opposite in direction. In this situation, the forces are balanced.

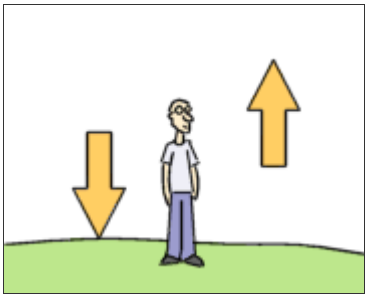
There are many different types of forces. A few are shown below:



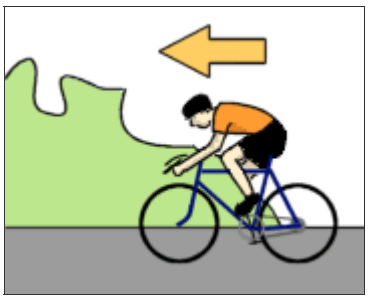
1. Magnetic forces



2. Tension



3. Gravitational forces

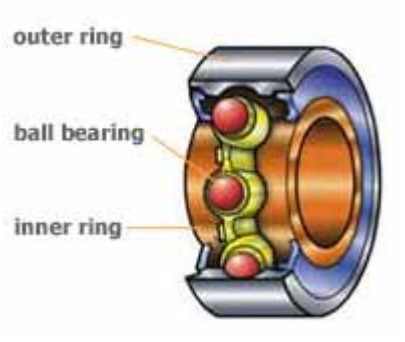


4. Forces of motion

FRICTION

Friction is a force that tries to stop materials gliding past each other. It occurs where two solid objects rub against each other. The amount of friction between two objects depends on how well the surfaces grip each other.

Friction can prevent machinery from moving freely. It also causes any moving parts to heat up. That's why heavy machinery often use lubricants, such as oil, to help keep the parts moving smoothly. To reduce friction, wheels are often mounted on ball bearings or oil is used to make moving surfaces more slippery.



Inside a bearing

Friction can be quite useful. It allows shoes and tyres to grip to the ground. It is also useful in braking systems.

WORK

Work is done whenever a force produces movement or, put another way, when a force moves something, work is done.

$$\text{Work} = \text{Force} \times \text{Distance}$$

The greater the force and the greater the distance moved, the more work is done. Whenever work is done, energy is changed into a different form.

The unit of work is the *joule*. One joule of work is done when a force of one Newton moves the point at which it acts through a distance of one metre.

Things have energy if they are able to do work. A human body has energy; a full tank of petrol has energy; the wind has energy. Energy, like work, is measured in joules and it exists in lots of different forms.

ENERGY

Energy cannot be made or destroyed but it can be changed from one form into another. The quantity of energy that changes from one form to another can be considered as transferred energy. This transferred energy is equal to the work done.

There are many different forms of energy:

Light
White light is made up of different colours — red, orange, yellow, green, blue, indigo and violet. You can see these colours when moisture in the air causes white light to disperse, e.g., a rainbow. Light energy is converted into food energy by plants in a process called photosynthesis.

Heat
When we heat something we make the particles move faster. You may think that ice is very cold. Actually, it is quite warm compared to outer space and the molecules in the ice are vibrating quite fast.

Sound
When you pluck a guitar string the vibrating string makes the air around it vibrate. The vibrating air or sound waves travel to your ear and make your eardrum vibrate. You interpret this as sound.

Kinetic Energy
Kinetic energy refers to the energy of a moving object.

Chemical Energy

Chemical energy refers to the energy held in the molecules of a substance. The chemical energy in a candle or coal, for example, is released when it burns. This energy is used to help us see or to keep us warm.

Gravitational Energy

Gravitational energy refers to energy involved in the pull of gravity on an object. When an object is at a height above the ground, it has potential energy. When it is released and falls to the ground, this potential energy is released when it hits the ground. Hydroelectric power stations use gravitational energy — water stored at a height is released and as it falls it turns turbines in the generator which produce electricity.

Nuclear Energy

Nuclear energy refers to the energy present in atoms and released in nuclear reactions.

POWER

Power is work divided by time. The unit of power is the watt. One unit of power is equivalent to a unit of work divided by a unit of time. Or, one watt is equivalent to one joule per second.

$$\text{Power} = \text{Work} \div \text{Time}$$

Work can be described in terms of a force that causes a change or displacement. Work has nothing to do with the amount of time it takes for this force to cause the displacement. Sometimes, the work can be done very quickly and other times the work can be done rather slowly.

Both girls move 20m up a mountain.
Which one has the greater power rating?

For example, a rock climber takes an abnormally long time to lift her body up a few metres along the side of a mountain. On the other hand, a hill walker (who takes the easier path up the mountain) might lift her body a few metres in a short amount of time. The two people might do the same amount of work, yet the hill walker does the work in considerably less time than the rock climber. Power has to do with the rate at which a certain amount of work is done. The hill walker has a greater power rating than the rock climber.