

# Energy and Forces

## Energy

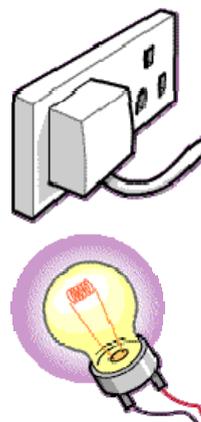
Energy gives you the ability to do work. Energy can be transformed from one form to another. Below are some examples of things that have, and can transfer, energy.



The vibrating drum and the plucked guitar string transfer energy to the air in the form of a sound wave. This **sound energy** can be transferred to your eardrum as movement or **kinetic energy**.

Sound energy → kinetic energy

The electrons moving in the wire have **electrical energy** as they come out of the socket, and when they reach the light bulb they transfer this energy as **light energy** and **heat energy**.



electrical energy → light energy + heat energy



The boulder on the mountain has energy because of its position above the ground and the pull of gravity. This energy is called **gravitational potential energy**, and is transferred into moving or **kinetic energy** as it falls to the ground.

gravitational potential energy → kinetic energy

A cup of hot tea has **heat energy** in the form of movement (kinetic energy) of its molecules. This is transferred to the slower-moving molecules in cold milk which you pour in to make it cooler.



heat energy of tea → heat energy of milk



When the explosive is detonated, **chemical energy** stored in the explosive is released in a chemical reaction as **heat and sound energy**.

Chemical energy → heat energy + sound energy

## **Storing energy**

When an elastic band is stretched or a clock spring wound up, energy can be stored as potential energy. Energy can also be stored in a battery or fuel (chemical energy) and released later. Energy can also be saved as gravitational potential energy, such as when water is stored behind a dam and released to flow, turn turbines, and transfer energy into electrical energy.

The transfer of energy:

- Energy is never destroyed, nor is it created; but it can be transferred from one form to another.
- When there is a temperature difference between two objects, energy is always transferred from the higher temperature to the lower temperature.
- Whenever there is a change, the total energy before the change is equal to the total energy after the change. This is the principle of the conservation of energy

## **Energy resources**

The Sun is the ultimate source of all of our energy. The Sun's light energy is transferred into many forms:

- by plant photosynthesis into biomass such as wood.
- by plant photosynthesis into biomass eaten as food by animals.
- by plant photosynthesis into biomass, that is transferred into chemical energy stored in the fossil fuels coal, gas and oil.

The Sun's heat energy is transferred:

- into movement by moving blocks of air in winds.
- into movement by winds causing water waves.
- to the energy's surface and atmosphere, raising the temperature and helping chemical reactions to happen.

## **Useful energy and wasted energy**

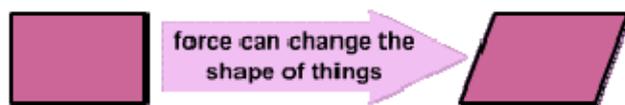
Energy used in doing a job we want carried out, such as lifting an object or moving a car, is called useful energy. When energy is transferred as useful energy there is always energy wasted. Energy that is wasted is "lost" (or dissipated) as other forms of energy, normally heat. A car produces useful work as movement but dissipates heat and sound energy. Friction, air resistance and electrical resistance are some of the main causes of energy being dissipated.

No machine can convert 100% of the energy transferred to useful energy. Power stations generate electricity by transferring energy from chemicals such as coal, oil, gas or nuclear sources to heat energy. This energy is transferred to kinetic energy and then transferred to electrical energy. All along this chain of transfer, energy is "lost".

## Forces

Forces are essentially pushes or pulls. A force (measured in Newtons or N) always has a direction in which it acts. Forces can not be seen. We use arrows to show the direction in which the force is acting. You can measure force with a Newton meter (sometimes called a spring balance).

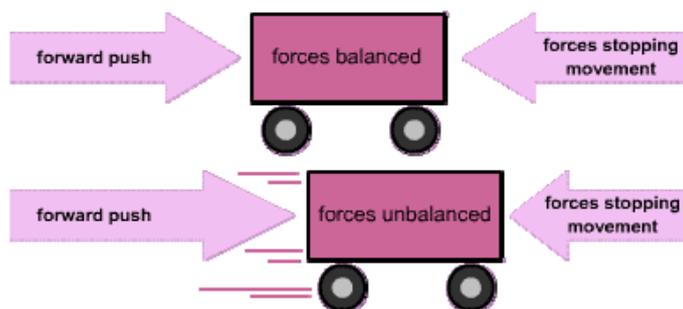
Forces can change the shape of things:



## Pairs of forces

Forces generally act in pairs. For example a space rocket moves because of the **reaction** force on it when hot gases are propelled out of its engine creating an **action** force.

When objects remain stationary (or moving at the same speed) it is because the forces acting on them are all equal and balanced.



## Motion and gravity

Forces can make moving things go faster or slower.

Forces can change the direction in which an object moves. When one moving object hits another they may both change direction. The force causing the change is called a contact force. When one force acting on an object is greater than the net effect of the other forces acting on the object, the object will move in the same direction as the applied force.

An object will move at constant speed if the force remains the same. If the force becomes greater the object will speed up (accelerate) or slow down (decelerate).

All objects are affected by gravity. The Earth pulls you down and gives you weight. On the Earth's surface a mass of 1 kg exerts a weight force of 10N.

The more dense and massive an object, the greater the gravitational force pulling towards the centre of the Earth. An object can spin or orbit around a planet in space because the forward motion of the object balances the pulling force of the planet's gravity.

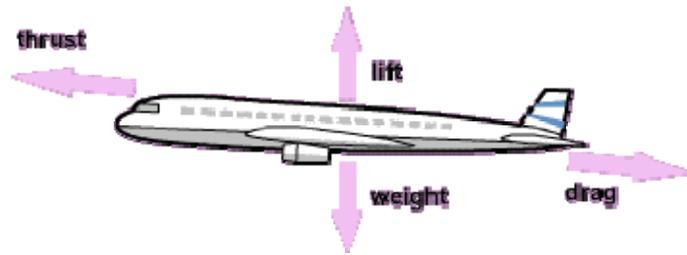
## Friction

An object travelling at speed has a force called friction acting on it to slow down its motion. Friction can be reduced by lubricants, ball bearing and other suitable methods. However, friction can be useful as well.

Friction between the tyres and the road enables a vehicle to move because the tyres grip the road. We can walk because of the grip between the soles of our shoes and the pavement.

In air or water friction is called drag or air/water resistance. Energy is needed to overcome these frictional forces, and this reduces the maximum speed we can reach. To reduce friction, the shape of the object can be streamlined by using curved surfaces and rounded corners.

An aircraft or object flying in a straight line at constant speed does so because all the forces are balanced. The lift of the wings is equal to the weight or downward force caused by gravity; and the thrusting force of the engine is equal to the air resistance or drag.



## Levers

Simple machines can be used to magnify forces, make things move faster or change the direction of the force. Levers are simple machines which make work easier by multiplying the force you are using.

Forces can be made to move things by turning the object around a pivot or fulcrum. It's just like a seesaw: the downward force of the effort causes the load, on the other side, to move up. When the two forces are equal there is no movement and the seesaw is balanced or in equilibrium.

