Work, Energy and Power

Key Words

energy	mechanical	kinetic	thermal	wedge	fulcrum
work	joule	potential	lever	wheel	effort
power	watt	electrical	pulley	axel	load

Work

In everyday language, work might be doing homework, or watering the plants. But to scientist, work has a precise meaning: work is done if a **force** makes something **move**. The greater the force, the greater the distance so the more work is done.

The SI unit of work is the **joule (J)**: $1\ J = 1\ N \cdot m$

Energy is needed to do work, and when we do work, energy is transferred by the action of the force.

We can define **work** as the force times the distance moved in the direction of the force

Work is calculated using the following equation

$$W = F \cdot s$$

E.g. If a 8 N force moves an object 4 m, the work done is 32 J

Energy

Energy is a property of bodies. Thanks to energy, objects can move or undergo changes. So things have energy if they can be used to do work.

Basically we can say that **energy is the capacity something has to do work**

The SI unit of energy is also the **joule (J)**.

Power

Power is the rate at which energy is transferred. If energy is transferred by a force doing work on an object, **Power (P) is the rate at which work is done (work per unit of time).**

$$P = \frac{W}{t}$$

The SI unit for power are **watts (W)**;
$1\ kW = 10^3\ W$

$$\mathbf{1\ W = 1\ J/s}$$

(The watt is defined as the power of an engine that is capable of doing a work of 1 joule in 1 second)

Forms of Energy, Energy Transformations and the Law of Conservation of Energy

Energy can take different forms. Some of the main forms of energy are:

- **Electrical energy** produced by the movement of electrical charges (electrons) through a conductor. Among others, electrons can transfer energy into light (lightbulbs); into mechanical work (motors); or into heat (stoves).
- **Mechanical energy**:

Kinetic energy: energy due to motion. All moving objects have kinetic energy.

$$E_k = \frac{m \cdot v^2}{2}$$

Potential energy: potential energy is the energy stored in a system. We will study **gravitational potential energy**, which is a form of energy associated with the position of an object.

$$E_p = m \cdot g \cdot h$$

where $g = 9{,}8\ m/s^2$ (acceleration of gravity), but in this course we will use $g = 10\ m/s^2$

✓ The **total mechanical energy** is the sum of both energies:

$$E_m = E_k + E_p$$

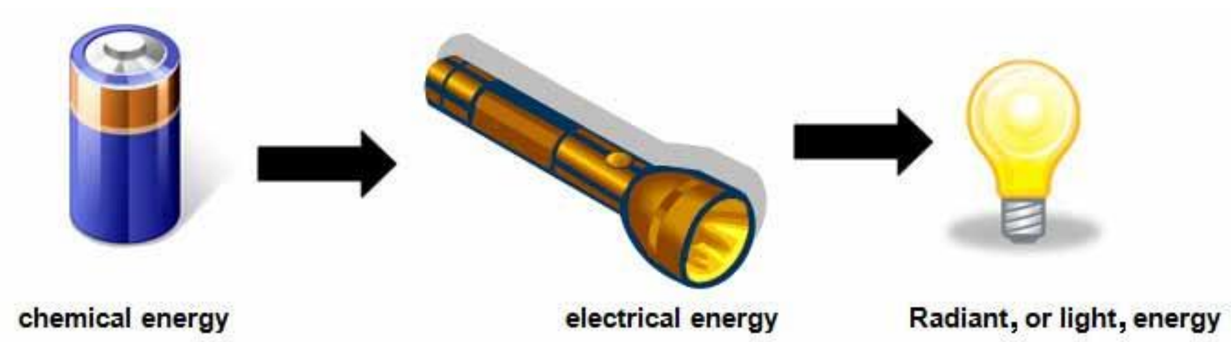
- **Thermal energy:** as hot objects cool down, the atoms slow down and loose energy in the form of heat.

According to the source or energy, among others, we can talk about:

- **Solar energy: (energy radiated from the Sun)** Sun energy which reaches the Earth in its different forms (mainly light, heat and ultraviolet rays).
- **Hydroelectric energy:** the energy of water flowing down from a height, behind a dam; so it has gravitational potential energy, which is transformed into electrical energy.
- **Wind energy:** the motion energy of 'wind flow', which is usually transformed into electrical energy by wind turbines.
- **Geothermal energy:** a type of renewable energy which uses the heat within the Earth.
- **Chemical energy**: energy release by chemical reactions. For example, when fuels burn.
- **Nuclear energy**: energy released when particles inside the nucleus of an atom, which are held together by strong forces, are rearrange, or if the nucleus splits.

Law of conservation of energy:
Energy is not created, nor can it be destroyed, but it can change from one form to another.

Energy is conserved in quantity, but for each time it is transformed, it becomes less usable.



("Texas Gateway", 2017)

Simple Machines

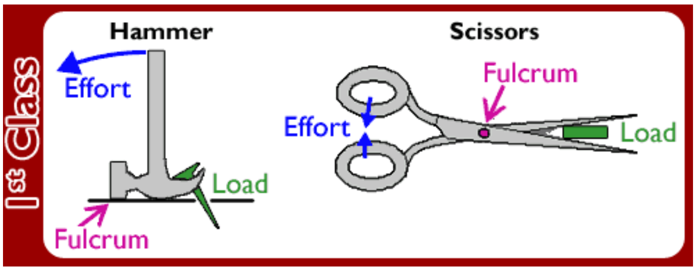
Simple machines are simple devices that make work easier by changing the amount of force required to the work, therefore also changing the distance over which the force is applied.

There are six basic types of simple machines: the lever, the pulley, the wheel and axle, the inclined plane, the wedge and the screw.

The lever: a rigid rod or **lever** arm that rotates about a fixed point called the *fulcrum.* There are 3 classes or levers.

1st Class lever: the fulcrum is between the effort (input force), and the load (output force).

("Levers have a lot of Class | City Technology", 2017)



2nd Class lever: the fulcrum is at one end and the effort (input force) is at the other end

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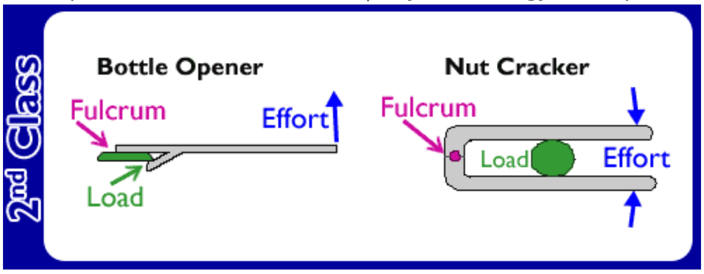

3rd Class lever: the fulcrum is at one end and the load (output force) is at the other end. The effort (input force) acts between the fulcrum and the load.

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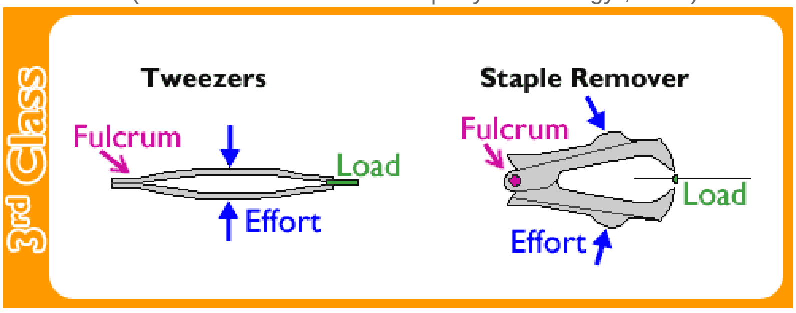

Different examples of the three classes of levers.

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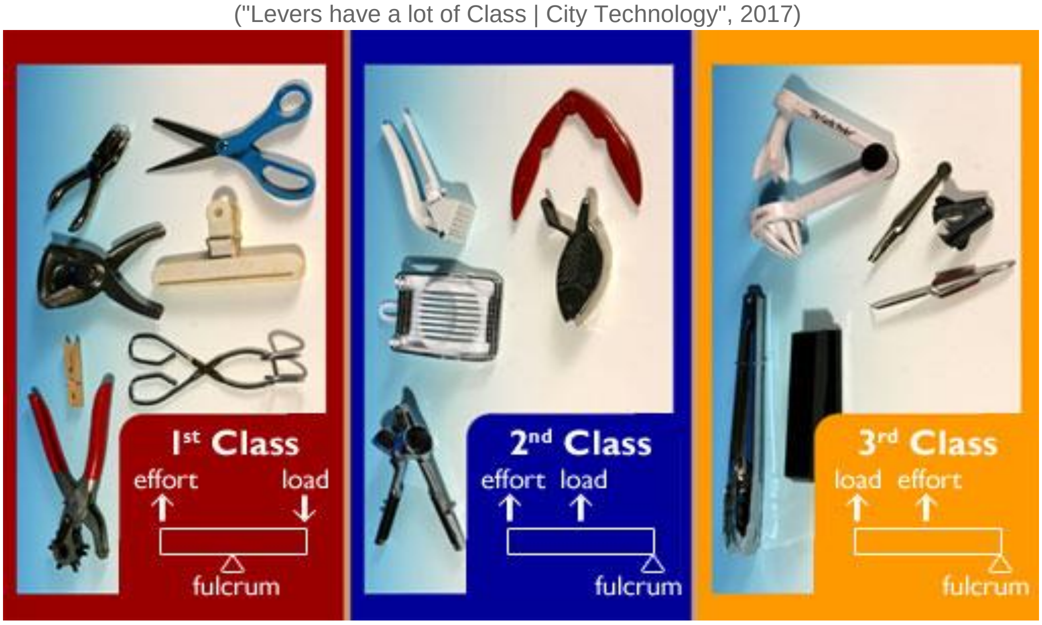
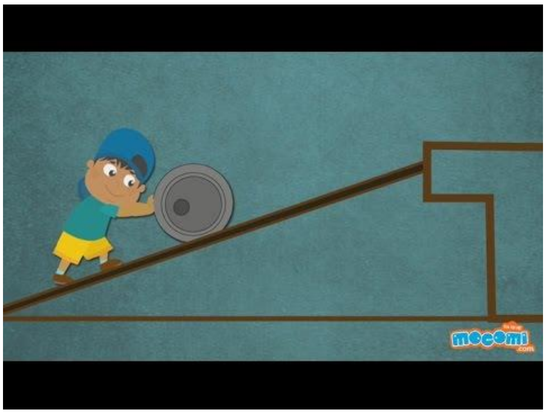


Inclined plane: they make work easier by increasing the distance over which force is applied, making the effort (input force) less.



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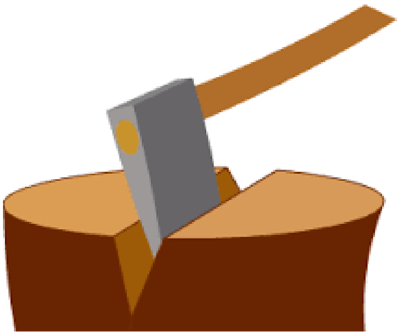
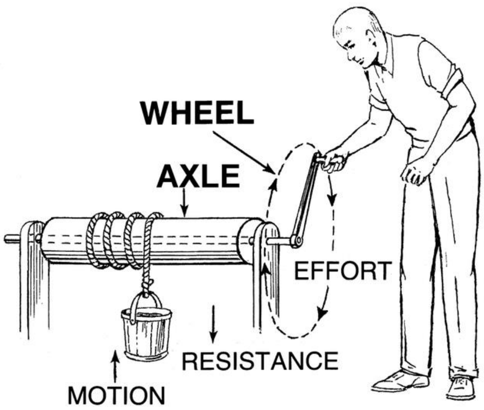
Wedge: essentially two inclined planes that meet at one point (back-to-back). They multiply and redirect the force to push two surfaces apart.



("Wedge Examples", 2017)

Wheel and axel: essentially a cylinder attached to a central shaft. It is the most important of all responsible for our technological development.



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The pulley: is a wheel with a rope threaded around it. A single pulley does not multiply the force, it just redirects the force, which makes it easier to lift the load.

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