

# SCIENCE & ENERGY

## convection

Heat generation in a fluid that is caused by a variation in temperature resulting from the movement of molecules. Here, the heated water expands, rises and releases its heat to the surrounding air.



## vapor

Gaseous state of water above its boiling point (water boils and is converted to vapor at 212°F or 100°C).

## liquid

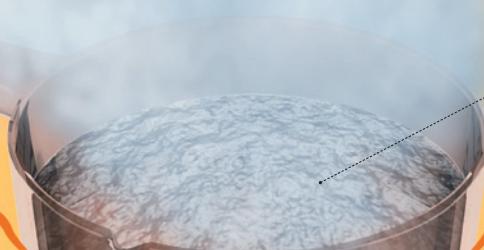
Matter having a definite mass and volume but no shape; its atoms are relatively mobile in relation to each other.

## radiation

Heat generation in the form of electromagnetic waves emitted by a heated body (solid, liquid or gas).

## convection current

Movement of fluid caused by a difference in density, which transfers heat. The heated water rises and is replaced by the cooler water from the surface.



## flame

Incandescent gas resulting from the combustion of a mixture of gas and air; it produces heat and light.

## solid

Rigid body possessing mass, volume and a definite form; its atoms are linked to each other and are almost completely at rest.

## conduction

Heat generation in a body (usually a solid) or between two bodies in contact; the molecules vibrate but no matter moves.

# SCIENCE & ENERGY

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Ariane **Archambault**

## A C K N O W L E D G E M E N T S

**Our deepest gratitude to the individuals, institutions, companies, and businesses that have provided us with the latest technical documentation for use in preparing this dictionary.**

Arcand, Denys (motion picture director); International Association of Marine Aids to Navigation and Lighthouse Authority; Canadian Payments Association (Charlie Clarke); Canadian Bankers Association (Lise Provost); Automobiles Citroën; Automobiles Peugeot; Bank of Canada (Lyse Brousseau); Royal Bank of Canada (Raymond Chouinard, Francine Morel, Carole Trottier); Barrett Xplore inc.; Bazarin, Christine; Library of Canadian Parliament (Information Services); Bibliothèque nationale du Québec (Jean-François Palomino); Bluechip Kennels (Olga Gagne); Bombardier Aerospace; Bridgestone-Firestone; Brother (Canada); Canadian National; Casavant Frères ltée; C.O.J.O. ATHENS 2004 (International Media Service); Centre Eaton de Montréal; Centre national du costume (Recherche et diffusion); Cetacean Society International (William R. Rossiter); Chagnon, Daniel (architect D.E.S. - M.E.Q.); Cohen et Rubin Architectes (Maggy Cohen); Commission scolaire de Montréal (École St-Henri); Hudson Bay Company (Nunzia Iavarone, Ron Oyama); Corporation d'hébergement du Québec (Céline Drolet); National Theatre School of Canada (Library); Élevage Le Grand Saphir (Stéphane Ayotte); Atomic Energy of Canada; Eurocopter; Famous Players; Fédération bancaire française (Védi Hékimian); Fontaine, PierreHenry (biologist); Future Shop; Garaga; Groupe Jean Coutu; Hôpital du Sacré-Cœur de Montréal; Hôtel Inter-Continental; Hydro-Québec; I.P.I.Q. (Serge Bouchard); IGA Barcelo; International Entomological Society (Dr. Michael Geisthardt); Irisbus; Jérôme, Danielle (O.D.); La Poste (Colette Gouts); Le Groupe Canam Manac inc.; Lévesque, Georges (urgentologist); Lévesque, Robert (chief machinist); Manutan; Marriott SpringHill Suites; MATRA S.A.; Métro inc.; National Defence of Canada (Public Affairs); ministère de la Défense, République Française; ministère de la Justice du Québec (Service de la gestion immobilière - Carol Sirois); ministère de l'Éducation du Québec (Direction de l'équipement scolaire - Daniel Chagnon); Muse Productions (Annick Barbery); National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; Nikon Canada inc.; Normand, Denis (telecommunications consultant); Office de la langue française du Québec (Chantal Robinson); Paul Demers & Fils inc.; Phillips (France); Pratt & Whitney Canada inc.; Prévost Car inc.; Radio Shack Canada ltée; Réno-Dépôt inc.; Robitaille, Jean-François (Department of Biology, Laurentian University); Rocking T Ranch and Poultry Farm (Pete and Justine Theer); RONA inc.; Sears Canada inc.; Public Works and Government Services Canada: Translation Bureau; Correctional Service Canada; Société d'Entomologie Africaine (Alain Drumont); Société des musées québécois (Michel Perron); Société Radio-Canada; Sony du Canada ltée; Sûreté du Québec; Théâtre du Nouveau Monde; Transport Canada (Julie Poirier); Urgences-Santé (Éric Berry); Ville de Longueuil (Direction de la Police); Ville de Montréal (Service de la prévention des incendies); Vimont Lexus Toyota; Volvo Bus Corporation; Yamaha Motor Canada Ltd.

*Science & Energy* was created and produced by

ISBN 978-2-7644-0881-0



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Printed and bound in Singapore  
10 9 8 7 6 5 4 3 2 1 12 11 10 09

**[www.qa-international.com](http://www.qa-international.com)**

Version 3.5.1

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## CONTRIBUTIONS

QA International wishes to extend a special thank you to the following people for their contribution to this book:

Jean-Louis Martin, Marc Lalumière, Jacques Perrault, Stéphane Roy, Alice Comtois, Michel Blais, Christiane Beauregard, Mamadou Togola, Annie Maurice, Charles Campeau, Mivil Deschénes, Jonathan Jacques, Martin Lortie, Frédéric Simard, Yan Tremblay, Mathieu Blouin, Sébastien Dallaire, Hoang Khanh Le, Martin Desrosiers, Nicolas Oroc, François Escalme, Danièle Lemay, Pierre Savoie, Benoit Bourreau, Marie-Andrée Lemieux, Caroline Soucy, Yves Chabot, Anne-Marie Ouellette, Anne-Marie Villeneuve, Anne-Marie Brault, Nancy Lepage, Daniel Provost, François Vézina, Guylaine Houle, Daniel Beaulieu, Sophie Pellerin, Tony O'Riley, Mac Thien Nguyen Hoang, Serge D'Amico.

# INTRODUCTION

## EDITORIAL POLICY

*The Visual Dictionary* takes an inventory of the physical environment of a person who is part of today's technological age and who knows and uses a large number of specialized terms in a wide variety of fields.

Designed for the general public, it responds to the needs of anyone seeking the precise, correct terms for a wide range of personal or professional reasons: finding an unknown term, checking the meaning of a word, translation, advertising, teaching material, etc.

The target user has guided the choice of contents for *The Visual Dictionary*, which aims to bring together in 12 thematic books the technical terms required to express the contemporary world, in the specialized fields that shape our daily experience.

## STRUCTURE

Each tome has three sections: the preliminary pages, including the table of contents; the body of the text (i.e. the detailed treatment of the theme); the index.

Information is presented moving from the most abstract to the most concrete: sub-theme, title, subtitle, illustration, terminology.

## TERMINOLOGY

Each word in *The Visual Dictionary* has been carefully selected following examination of high-quality documentation, at the required level of specialization.

There may be cases where different terms are used to name the same item. In such instances, the word most frequently used by the most highly regarded authors has been chosen.

Words are usually referred to in the singular, even if the illustration shows a number of individual examples. The word designates the concept, not the actual illustration.

## DEFINITIONS

Within the hierarchical format of *The Visual Dictionary*'s presentation, the definitions fit together like a Russian doll. For example, the information within the definition for the term *insect* at the top of the page does not have to be repeated for each of the insects illustrated. Instead, the text concentrates on defining the distinguishing characteristics of each insect (the *louse* is a parasite, the female *yellow jacket* stings, and so forth).

Since the definition leaves out what is obvious from the illustration, the illustrations and definitions complement one another.

The vast majority of the terms in the *Visual Dictionary* are defined. Terms are not defined when the illustration makes the meaning absolutely clear, or when the illustration suggests the usual meaning of the word (for example, the numerous *handles*).

## METHODS OF CONSULTATION

Users may gain access to the contents of *The Visual Dictionary* in a variety of ways:

- From the TABLE OF CONTENTS at the end of the preliminary pages, the user can locate by title the section that is of interest.
- With the INDEX, the user can consult *The Visual Dictionary* from a word, so as to see what it corresponds to, or to verify accuracy by examining the illustration that depicts it.
- The most original aspect of *The Visual Dictionary* is the fact that the illustrations enable the user to find a word even if he or she only has a vague idea of what it is. The dictionary is unique in this feature, as consultation of any other dictionary requires the user first to know the word.

## TITLE

Its definition is found below. If the title refers to information that continues over several pages, after the first page it is shown in a shaded tone with no definition.

## DEFINITION

It explains the inherent qualities, function, or characteristics of the element depicted in the illustration.

## TERM

Each term appears in the index with a reference to the pages on which it appears.

## SUB-THEME

These are shown at the end of the preliminary pages along with their definitions. They are then repeated on each page of a section, but without the definition.

matter	CHEMISTRY	matter
<p><b>atom</b> Fundamental unit of matter having unique chemical properties. It is composed of a nucleus and an electron cloud. Its mass is much more than another by the number of protons in its nucleus.</p> <p><b>nucleus</b> Central part of an atom having electric charge positive. It is composed of protons and neutrons, around which electrons revolve.</p> <p><b>neutron</b> Constituent particle of an atom whose electric charge is neutral. It is composed of one u quark and two d quarks.</p> <p><b>proton</b> Constituent particle of an atom whose electric charge is positive. It is composed of two u quarks and one d quark.</p> <p><b>electron</b> Particle having a negative electric charge that revolves around the nucleus of the atom.</p> <p><b>molecule</b> Matter composed of atoms that constitutes the smallest unit of a pure substance that can exist in a free state (e.g., water or carbon dioxide).</p> <p><b>atoms</b> All matter in the universe is composed of approximately 100 types of atoms.</p> <p><b>d quark</b> The d quark (down) is one of six types of quarks (constituent particles of protons and neutrons) having a negative electric charge.</p> <p><b>s quark</b> The s quark (strange) is one of six types of quarks (constituent particles of the proton and neutron) having a positive electric charge.</p> <p><b>chemical bond</b> Force that unites two atoms through the sharing of one or more pairs of electrons (ionic bond) or the transfer of electrons (ionic bond) to form a molecule.</p>	<p><b>condensation</b> Change of a substance from a gaseous state directly to a liquid state; it results from cooling.</p> <p><b>saturation</b> Change of a substance from a solid state directly to a gaseous state; it results from heating.</p> <p><b>crystallization</b> Change of a substance from an amorphous state to a crystalline state; it results from cooling, which causes the atoms to become ordered.</p> <p><b>amorphous solid</b> Body that resembles a correlated liquid whose atoms are not ordered.</p> <p><b>gas</b> Matter in a gaseous state; its atoms are fully mobile with respect to each other.</p> <p><b>evaporation</b> Change of a substance from a liquid state to a gaseous state; it results from heating.</p> <p><b>supersaturation</b> The point of cooling a liquid below the point at which it normally freezes (solidifies); its atoms become unstable.</p> <p><b>liquid</b> Matter having a definite mass and volume but no shape; its atoms are relatively much closer to each other.</p> <p><b>solid</b> Rigid body possessing mass, volume and a definite form; its atoms are linked to each other and are almost completely at rest.</p> <p><b>freezing</b> Change of a substance from a liquid state to a solid state; it results from cooling.</p> <p><b>melting</b> Change of a substance from a solid state to a liquid state; it results from heating.</p>	<p><b>states of matter</b> Matter exists in three fundamental states (solid, liquid and gaseous), which depend on the temperature and pressure to which the matter is subjected.</p>

## ILLUSTRATION

It is an integral part of the visual definition for each of the terms that refer to it.

## NARROW LINES

These link the word to the item indicated. Where too many lines would make reading difficult, they have been replaced by color codes with captions or, in rare cases, by numbers.

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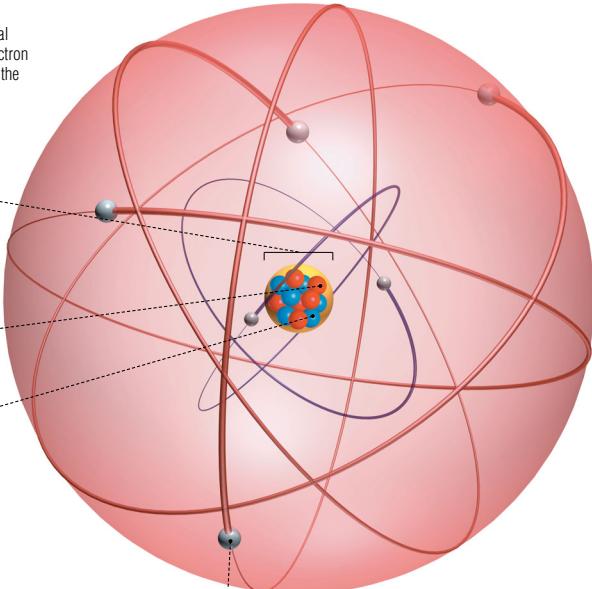
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# matter

Any substance that has mass, is composed of atoms and occupies space.

## atom

Fundamental unit of matter having unique chemical properties; it is composed of a nucleus and an electron cloud. One atom is distinguished from another by the number of protons in its nucleus.



### nucleus

Central part of the atom whose electric charge is positive; it is composed of protons and neutrons, around which electrons revolve.

### neutron

Constituent particle of an atom's nucleus whose electric charge is neutral; it is composed of one u quark and two d quarks.

### proton

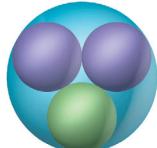
Constituent particle of an atom's nucleus whose electric charge is positive; it is composed of two u quarks and one d quark.

### electron

Particle having a negative electric charge that revolves around the nucleus of the atom.

## proton

Constituent particle of an atom's nucleus whose electric charge is positive; it is composed of two u quarks and one d quark.

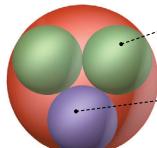


## molecule

Matter composed of atoms that constitutes the smallest unit of a pure body that can exist in a free state (e.g., water and carbon dioxide).

## neutron

Constituent particle of an atom's nucleus whose electric charge is neutral; it is composed of one u quark and two d quarks.

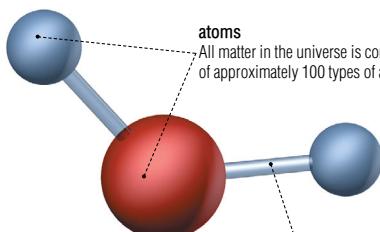


## d quark

The d quark (down) is one of six types of quarks (constituent particles of protons and neutrons) having a negative electric charge.

## u quark

The u quark (up) is one of six types of quarks (constituent particles of the protons and neutrons) having a positive electric charge.



### atoms

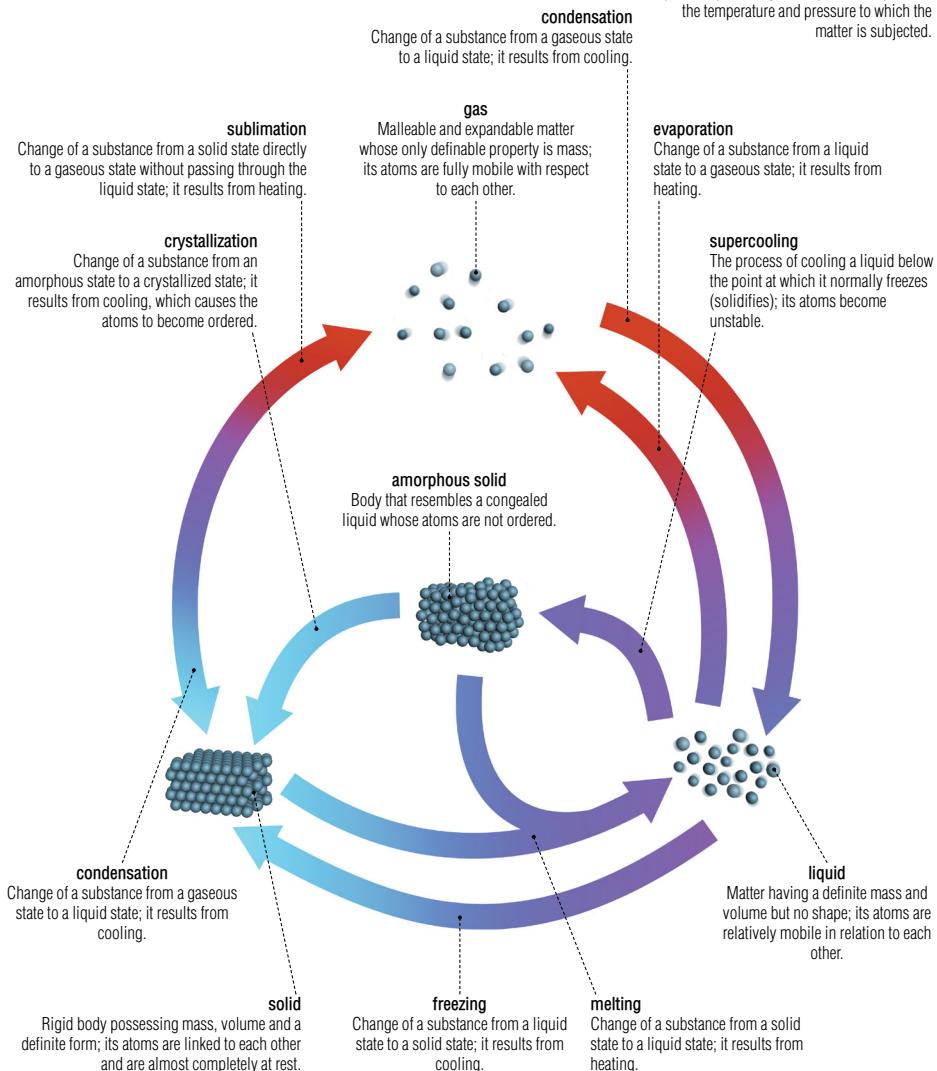
All matter in the universe is composed of approximately 100 types of atoms.

### chemical bond

Force that unites two atoms through the sharing of a common electron (covalent bond) or the transfer of electrons (ionic bond) to form a molecule.

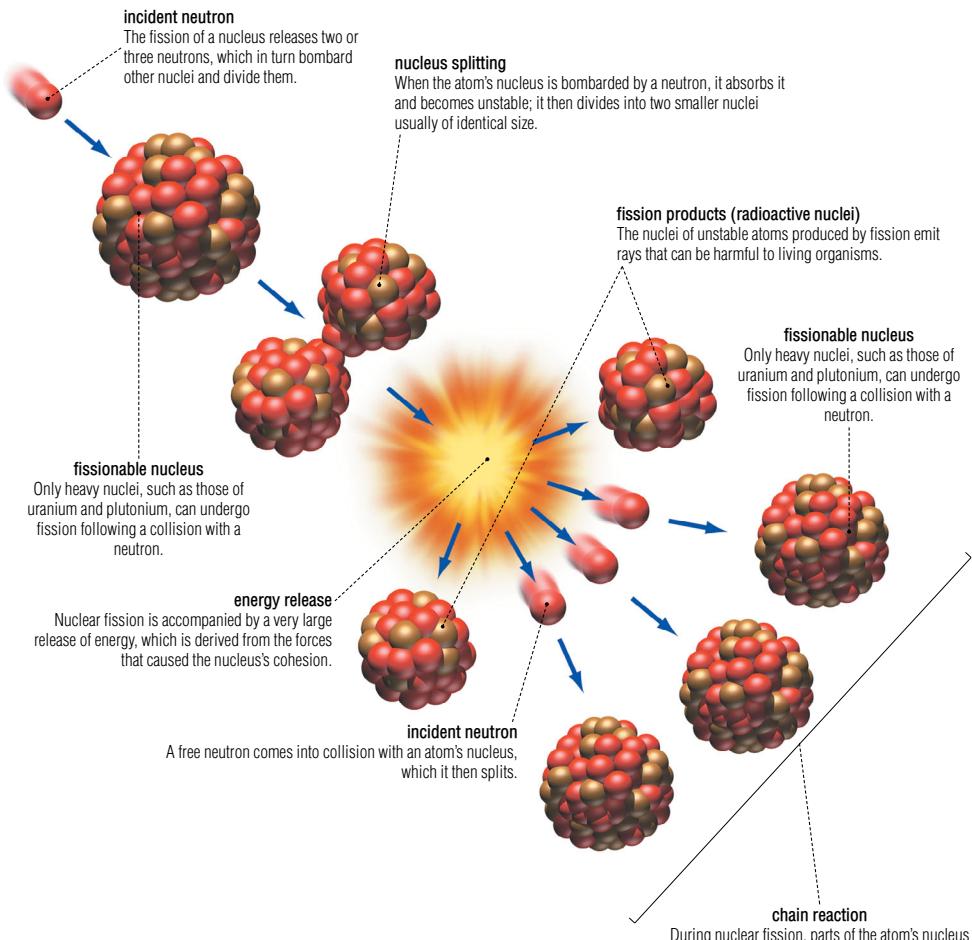
**states of matter**

Matter exists in three fundamental states (solid, liquid and gaseous), which depend on the temperature and pressure to which the matter is subjected.



**nuclear fission**

Process by which the atoms' nuclei become fragmented (e.g., in a nuclear reactor); neutrons are released and energy is produced in the form of heat.



**heat transfer**

Heat transfer occurs in three ways that are related to molecular movement: conduction, convection and radiation.

**convection**

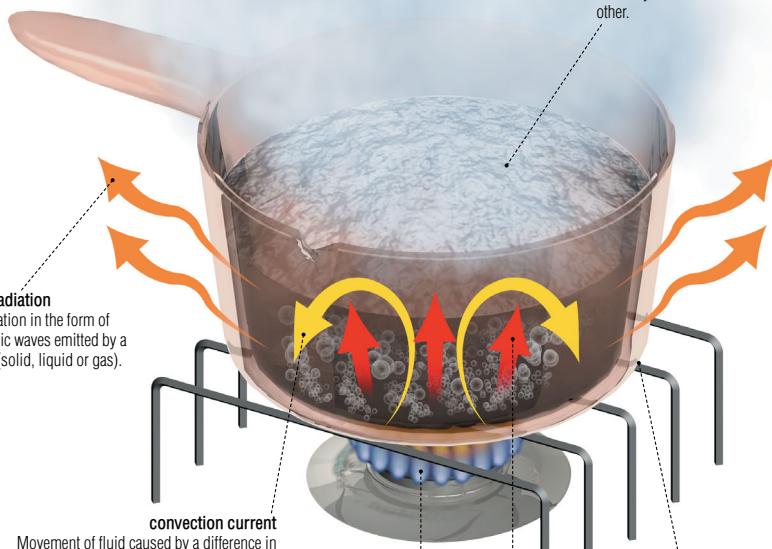
Heat generation in a fluid that is caused by a variation in temperature resulting from the movement of molecules. Here, the heated water expands, rises and releases its heat to the surrounding air.

**vapor**

Gaseous state of water above its boiling point (water boils and is converted to vapor at 212°F or 100°C).

**liquid**

Matter having a definite mass and volume but no shape; its atoms are relatively mobile in relation to each other.

**radiation**

Heat generation in the form of electromagnetic waves emitted by a heated body (solid, liquid or gas).

**convection current**

Movement of fluid caused by a difference in density, which transfers heat. The heated water rises and is replaced by the cooler water from the surface.

**flame**

Incandescent gas resulting from the combustion of a mixture of gas and air; it produces heat and light.

**conduction**

Heat generation in a body (usually a solid) or between two bodies in contact; the molecules vibrate but no matter moves.

# chemical elements

There are more than 110 chemical elements, most of which are naturally present in the universe. The others are created artificially in the laboratory.

## table of elements

Table created by Dmitry Mendeleyev in 1869 that classifies the now approximately 110 known chemical elements such as oxygen, hydrogen, iron and lead. The elements are classified in order of their atomic weight and arranged into groups having similar properties.

1 H										
3 Li	4 Be									
11 Na	12 Mg									
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co		
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh		
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir		
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt		
						58 Ce	59 Pr	60 Nd	61 Pm	62 Sm
						90 Th	91 Pa	92 U	93 Np	94 Pu

<sup>1</sup>  
H  
**hydrogen**

This gas is the most abundant element in the universe and makes up part of the composition of water. It is used especially in petrochemistry and rocket engines.

								<sup>2</sup> He
			<sup>5</sup> B	<sup>6</sup> C	<sup>7</sup> N	<sup>8</sup> O	<sup>9</sup> F	<sup>10</sup> Ne
			<sup>13</sup> Al	<sup>14</sup> Si	<sup>15</sup> P	<sup>16</sup> S	<sup>17</sup> Cl	<sup>18</sup> Ar
<sup>28</sup> Ni	<sup>29</sup> Cu	<sup>30</sup> Zn	<sup>31</sup> Ga	<sup>32</sup> Ge	<sup>33</sup> As	<sup>34</sup> Se	<sup>35</sup> Br	<sup>36</sup> Kr
<sup>46</sup> Pd	<sup>47</sup> Ag	<sup>48</sup> Cd	<sup>49</sup> In	<sup>50</sup> Sn	<sup>51</sup> Sb	<sup>52</sup> Te	<sup>53</sup> I	<sup>54</sup> Xe
<sup>78</sup> Pt	<sup>79</sup> Au	<sup>80</sup> Hg	<sup>81</sup> Tl	<sup>82</sup> Pb	<sup>83</sup> Bi	<sup>84</sup> Po	<sup>85</sup> At	<sup>86</sup> Rn
<sup>110</sup> Ds	<sup>111</sup> Rg	<sup>112</sup> Uub						
<sup>63</sup> Eu	<sup>64</sup> Gd	<sup>65</sup> Tb	<sup>66</sup> Dy	<sup>67</sup> Ho	<sup>68</sup> Er	<sup>69</sup> Tm	<sup>70</sup> Yb	<sup>71</sup> Lu
<sup>95</sup> Am	<sup>96</sup> Cm	<sup>97</sup> Bk	<sup>98</sup> Cf	<sup>99</sup> Es	<sup>100</sup> Fm	<sup>101</sup> Md	<sup>102</sup> No	<sup>103</sup> Lr

**alkali metals**

Generally soft and silvery and very good conductors of heat and electricity; they are very reactant with nonmetals and break down in cold water.

**lithium**

The lightest of all the metals is used especially in alloys for the aerospace industry, in household batteries and in medicine.

3  
Li**sodium**

Metal that is used especially in streetlights, kitchen salt (sodium chloride) and the manufacture of glass and cosmetic products.

11  
Na**potassium**

Very reactant light metal that is used especially in fertilizer and matches; its salts are used in medicine.

19  
K**rubidium**

Metal similar to potassium but much rarer that is used in the manufacture of photoelectric cells and special kinds of glass and lasers.

37  
Rb**cesium**

Rare metal that is used especially in photoelectric cells, atomic clocks, infrared lamps and treating certain cancers.

55  
Cs**francium**

The heaviest of the alkali metals is very rare and radioactive and has a very short life span (about 22 minutes).

87  
Fr**alkaline earth metals**

Generally silvery and malleable and good conductors of heat and electricity; they react easily with nonmetals and water.

**beryllium**

Uncommon metal that is used especially in alloys for the aerospace industry and as a moderator in nuclear reactors.

4  
Be**calcium**

Metal that is one of the most essential elements in bones and teeth; it is also a component of cement, plaster and some alloys.

20  
Ca**barium**

Relatively abundant metal that is used especially in lubricants, pyrotechnics (fireworks), paint and radiology.

56  
Ba**magnesium**

Metal necessary for the growth and metabolism of most living organisms; it is also a component of aluminum alloys.

12  
Mg**strontium**

Relatively rare metal that is used especially in pyrotechnics (fireworks), the manufacture of magnets and medicine.

38  
Sr**radium**

Extremely radioactive metal present in very low quantities in uranium ore; it is used mainly in medicine as a cancer treatment.

88  
Ra

**boron**

**5 B**  
Semimetal that is used especially as a neutron absorber in nuclear reactors, as a rocket fuel and in detergents.

**silicon**

**14 Si**  
Most common element on the planet after oxygen; it is used mostly in the manufacture of electronic devices because of its semiconductor properties.

**germanium**

**32 Ge**  
Rare semimetal that is used especially in the manufacture of electronic devices and in optical equipment (camera and microscope lenses).

**aluminum**

**13 Al**  
Light metal that is used especially in aeronautics, cars, buildings, electric cables, kitchen utensils and packaging.

**gallium**

**31 Ga**  
Rare metal that is used especially in high-temperature thermometers, electroluminescent diodes and television screens (the color green).

**indium**

**49 In**  
Very rare metal that is used especially in race car engines and electronic devices, and as a coating for glass.

**semi-metals (metalloids)**  
Nonmetallic elements that are lusterless and solid; they possess a certain amount of electric and thermal conductivity.

**arsenic**

**33 As**  
Toxic semimetal that is used especially in very low doses for therapeutic uses and in the manufacture of semiconductors.

**selenium**

**34 Se**  
Semimetal that is usually used in photoelectric cells and semiconductors; it is an indispensable trace element for organisms.

**tin**

**50 Sn**  
Metal that is used especially as an anticorrosive for copper and steel and as a component in the preparation of bronze, welding and toothpaste.

**thallium**

**81 Tl**  
Metal that is used especially in infrared detectors and some kinds of glass.

**lead**

**82 Pb**  
Heavy toxic metal that is used to prevent corrosion, as a protection against radiation and in accumulator batteries, paint and glass.

**antimony**

**51 Sb**  
Semimetal that is used in several alloys (mostly with lead) and especially in making metal for printing type and semiconductors.

**tellurium**

**52 Te**  
Rare semimetal that is used especially in the manufacture of detonators, electric resistors, rubber, ceramics and glass.

**other metals**

These elements are not part of any other category of metal; they are sometimes called posttransition metals.

**bismuth**

**83 Bi**  
Relatively rare metal that is used especially in alloys and cosmetics and in medicine (treatments for gastric ulcers and diarrhea).

**polonium**

**84 Po**  
Very rare radioactive metal that is used as fuel in nuclear reactors; it emits radiation that is much more powerful than that of uranium.

# chemical elements

## non-metals

Nonmetallic elements that are lusterless and nonmalleable; they are mostly gases and solids and are usually poor conductors of heat and electricity.

### carbon

Element common in its pure state (diamond, graphite) or found in combination (air, coal, petroleum); it is present in animal and plant tissue.

### nitrogen

Gas that constitutes about 78% of the Earth's atmosphere, present in all animal and vegetable tissue (proteins), and in fertilizer, ammonia and explosives.

### oxygen

Gas that is the most abundant element on Earth and that comprises about 20% of the atmospheric air; it is used to breathe and in the manufacture of steel.

### noble gases

Family of chemical elements also called inert, as they are weakly reactant.

### helium

The lightest of the noble gases is noncombustible and abundant in the stars; it is used especially in inflating aerostats (such as balloons and dirigibles).

### neon

Noble gas that is used mainly in lighting (billboards, television tubes and fog lamps), but also as a liquid coolant.

### fluorine

Gas that is used especially for enriching uranium and manufacturing antistick coatings; it is present in bones and teeth.

### sulfur

Solid that is quite common in nature; it is used in car batteries, fertilizer, paint, explosives, pharmaceuticals and rubber.

### krypton

Noble gas that is used in some incandescent lamps and in photography.

 Cl

### chlorine

Abundant toxic gas that is used to whiten fabric and paper, disinfect water and manufacture various other products (solvents).

 F

### bromine

Very toxic liquid that is used mainly to manufacture teargas, dyes and disinfectants and in photography and medications.

 P

### phosphorus

Solid used especially in fertilizer (phosphates), matches and pyrotechnics (fireworks); it is also necessary for human beings.

 Br

### iodine

Solid that is used especially in pharmaceuticals (revulsives, antiseptics), in photography and dyes; it is also essential for the human body.

 S

### astatine

Radioactive element that is extremely rare in nature; it is used in medicine to study the thyroid gland and to detect cancerous tumors.

 At

 Xe

### xenon

Rarest gas in the atmosphere; it is used mainly in discharge lamps, photoflash bulbs and lasers.

### radon

Highly radioactive noble gas that is used mainly in medicine (destroying cancerous tumors) and in predicting earthquakes.

 Rn

 Kr

**lanthanides (rare earth)**

Very reactant elements found in the lanthanide series (monazite, xenotime); some are relatively abundant in the Earth's crust.

**lanthanum**

Metal that reacts with water to yield hydrogen; it is used especially in flint alloys and optical glass.

57  
La**samarium**

Rare radioactive metal that is used especially in optical glass, lasers, nuclear reactors (absorbing neutrons) and permanent magnets.

62  
Sm**cerium**

The most common metal of the lanthanide group and the main constituent of flint alloys (misch metal).

58  
Ce**europerium**

The most reactant metal of the lanthanide group; it is used especially in television screens (the color orange) and nuclear reactors (absorbing neutrons).

63  
Eu**praseodymium**

Metal that is used especially in protective lenses, colorants for glass, flint alloys (misch metal) and permanent magnets.

59  
Pr**gadolinium**

Metal that is often alloyed with chromed steel; it is used especially in the manufacture of permanent magnets, magnetic heads and electronic components.

64  
Gd**neodymium**

One of the most reactant of rare metals; it is used mainly to manufacture lasers, eyeglasses and permanent-magnet alloys.

60  
Nd**terbium**

Rare metal that is used especially in lasers and semiconductors.

65  
Tb**promethium**

Radioactive metal that is used mainly in specialized batteries and luminescent coatings for watches, and as a source of X-rays in medicine.

61  
Pm**dysprosium**

Very rare metal that is used especially in permanent magnets, lasers and nuclear reactors (absorbing neutrons).

66  
Dy**holmium**

Very rare metal with limited applications; it is used in lasers and for coloring glass.

67  
Ho**erbium**

Metal that is used mainly in some alloys (especially with vanadium), lasers and infrared-absorbing glass, and as a colorant for glass and enamel.

68  
Er**thulium**

The rarest of the lanthanide group; it is used as a source of X-rays in portable radiology equipment and in the manufacture of ferrites (magnetic ceramics).

69  
Tm**ytterbium**

Metal that is used in the manufacture of stainless steel, in lasers and as a source of X-rays in portable radiology equipment.

70  
Yb**lutetium**

Very rare metal that is difficult to separate; it has no real industrial applications but can be used as a catalyst (cracking, hydrogenation).

71  
Lu

## chemical elements

**transition metals**

Usually less reactant than alkali metals and alkaline earth metals but very good electric and thermal conductors. Many of these metals form vital alloys.

**scandium**

 Rare and very light metal that is employed in aerospace construction because of its high fusion point (about 2,700°F or 1,500°C).

**titanium**

 Metal that is used in several alloys employed in the manufacture of precision items and as a coating for light aerospace parts.

**vanadium**

 Metal that is used mainly in alloys, to which it provides highly anticorrosive properties.

**chromium**

 Bright metal that is used as an anticorrosive coating and in the manufacture of hard and resistant alloys; it gives emeralds and rubies their color.

**manganese**

 Hard metal that is used mainly in the manufacture of specialty steels and household batteries; it is also an indispensable trace element for humans.

**iron**

 The most used metal in the world due to its variety of alloys (steel, cast iron); it helps move oxygen through the body.

**cobalt**

 Strong metal that is used in alloys (cutting tools, magnets) and in radiotherapy; it also yields a blue pigment.

**nickel**

 Hard metal that resists corrosion; it is used in the manufacture of coins and cutlery, and as a protective coating for other metals (iron, copper).

**copper**

 Reddish-brown metal that is a very good conductor of heat and electricity; it is used mainly in the manufacture of electric wire and alloys (brass, bronze).

**zinc**

 Relatively abundant metal that is resistant to corrosion; it is used especially in the manufacture of alloys, tires, paint, ointments and perfume.

**yttrium**

 Rare metal used in the manufacture of alloys, electronic components, lasers, television screens and in nuclear reactors.

**zirconium**

 Metal that is used in alloys for the nuclear industry (protective sheathing, fuel rods) and in jewelry (imitation diamonds).

**niobium**

 Rare metal that is used especially in alloys for jet aircraft, missiles, nuclear reactors, ointments and cutting tools.

**molybdenum**

 Hard metal that is used in alloys (aircraft, missiles, nuclear reactors), electric lights and electronic tubes.

**technetium**

 Radioactive metal (first element to have been produced artificially) that makes steel corrosion-free and is used in medical imaging.

**ruthenium**

 Rare metal that hardens platinum and palladium; it is used in the manufacture of electric contacts, spark plugs and jewelry.

**rhodium**

 Rare metal that resists corrosion and hardens platinum and palladium; it is used especially in catalytic converters and jewelry.

**palladium**

 Rare and precious metal that is used especially in dentistry (dental prostheses), jewelry (white gold) and in catalytic converters.

**silver**

47

Ag

Precious metal that is the best conductor of heat and electricity; it is used especially in the manufacture of mirrors, jewelry and coins.

**cadmium**

48

Cd

Metal that is used especially as a protective covering for steel, in rechargeable batteries and in nuclear reactors (control rods).

**hafnium**

72

Hf

Rare metal that is used in the control rods of nuclear reactors, filaments for incandescent lamps and jet engines.

**tantalum**

73

Ta

Somewhat rare metal that is highly resistant to heat; it is used especially in nuclear reactors, missiles and capacitors.

**tungsten**

74

W

Metal that is resistant to very high heat; it is used in filaments for incandescent lamps and cutting tools.

**rhenium**

75

Re

Rare metal that is resistant to wear and corrosion; it is used especially in pen tips and incandescent filaments for ovens.

**osmium**

76

Os

Rare metal often alloyed with iridium and platinum; it is used in pen tips, bearings, compass needles and jewelry.

**iridium**

77

Ir

Rare metal that is often alloyed with platinum; it is used especially in electric contacts and jewelry.

**platinum**

78

Pt

Very rare metal used especially as a catalyst in chemistry (petrochemicals, vitamins), in jewelry and in precision equipment.

**gold**

79

Au

Precious metal (nuggets, flakes) that is used as currency (ingots) and in jewelry, dentistry and electronics.

**mercury**

80

Hg

Rare metal that is used in measuring instruments (thermometers, barometers) and in the electricity industry.

**rutherfordium**

104

Rf

Artificial radioactive element that was first produced in laboratories in the 1960s; it has applications only in scientific research.

**dubnium**

105

Db

Artificial radioactive element that was first produced in laboratories in the 1960s.

**seaborgium**

106

Sg

Artificial radioactive element that was first produced in laboratories in 1974; it is based on californium and oxygen.

**bohrium**

107

Bh

Artificial radioactive element that was first produced in laboratories in 1976; it is based on bismuth and chromium.

**hassium**

108

Hs

Artificial radioactive element that was first produced in laboratories in 1984; it is based on lead and iron.

**meitnerium**

109

Mt

Artificial radioactive element that was first produced in laboratories in 1982; it is based on bismuth and iron.

**darmstadtium**

110

Ds

Artificial radioactive element that was first produced in laboratories in 1994; it is based on nickel and lead.

**roentgenium**

111

Rg

Artificial radioactive element that was first produced in laboratories in 1994; it is based on bismuth and nickel.

**ununbium**

112

Uub

Artificial radioactive element that was first produced in laboratories in 1996; it is based on lead and zinc.

## chemical elements

**actinides**

Radioactive elements that are abundant in nature (elements 89 to 92) or made artificially (elements 93 to 103). Most of them have no industrial applications.

**actinium**

Metal that is present in small quantities in uranium ore; it is used mainly as a source of neutrons in nuclear reactors.

89  
Ac**thorium**

Natural metal that is used especially in alloys, photoelectric cells and uranium production.

90  
Th**protactinium**

Very rare metal that is present in uranium ore; it has few applications outside of scientific research.

91  
Pa**uranium**

Naturally abundant metal that is used mainly as fuel in nuclear reactors as well as in nuclear weapons.

92  
U**neptunium**

Rare metal that is produced from uranium; it is used in neutron-detection instruments.

93  
Np**plutonium**

Metal that is produced from uranium; it is used especially as fuel in nuclear reactors as well as in nuclear weapons.

94  
Pu**americium**

Metal that is produced from plutonium; it is used mainly in smoke detectors and in radiology.

95  
Am**curium**

Metal that is produced in small amounts from plutonium; it is used especially in thermoelectric generators for spacecraft propulsion.

96  
Cm**berkelium**

Metal that is produced in small amounts from americium; it is used for scientific research only.

97  
Bk**californium**

Metal produced from curium that is used especially in the treatment of cancer and in some measuring instruments such as humidiostats.

98  
Cf**einsteinium**

Metal that was discovered in 1952 among the debris of the first thermonuclear explosion in the Pacific; it is used for scientific research only.

99  
Es**fermium**

Metal that was discovered at the same time as einsteinium; it is used for scientific research only.

100  
Fm**mendelevium**

Metal that is produced from einsteinium; it is named in honor of the chemist Mendeleev (who classified the elements).

101  
Md**nobelium**

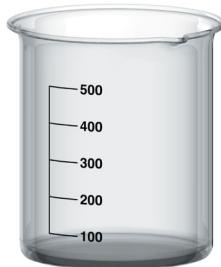
Metal that is produced from curium; it is named in honor of Alfred Nobel (inventor of dynamite and founder of the Nobel Prize).

102  
No**lawrencium**

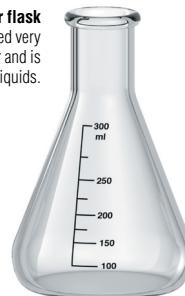
Metal that is produced from californium; it is used for scientific research only.

103  
Lr

These materials are highly varied: measurement instruments, various containers, heat sources, experimentation materials and mounting hardware.

**beaker**

Graduated container with a spout; it is used to create reactions (precipitation, electrolysis) and to measure approximate amounts of liquid.

**Erlenmeyer flask**

Graduated cone-shaped container that is used very frequently in laboratories; it can have a stopper and is used especially for mixing and measuring liquids.

**bottle**

Container of various sizes and shapes and usually with a straight neck for holding liquids.

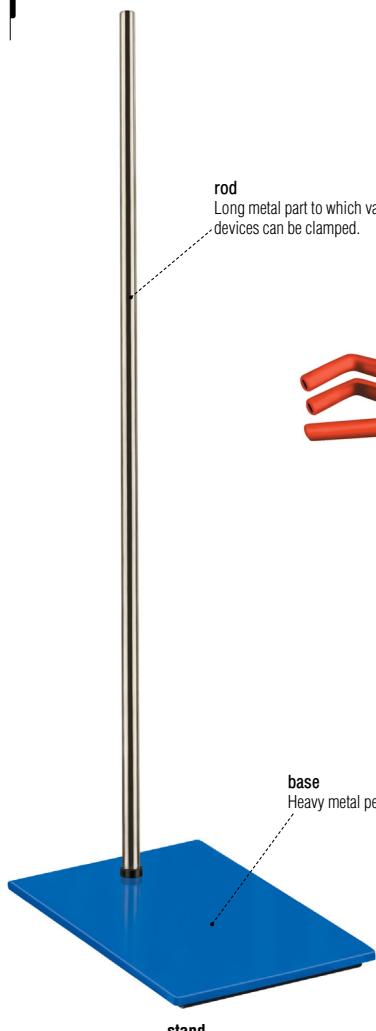
**wash bottle**

Flexible container that is squeezed lightly to squirt a liquid; it is used especially for cleaning equipment (test tubes, pipettes).

**round-bottom flask**

Spherical container used mainly for boiling liquids.

## laboratory equipment



**stand**  
Unit consisting of a base and a rod; it supports various laboratory apparatuses such as burettes and flasks.



**holder**  
Part with a screw for attaching a clamp onto the stand's rod.



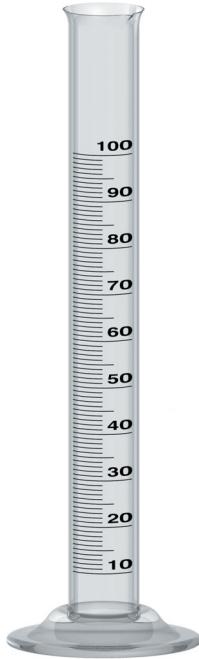
**clamp/holder**  
Part attached to the stand's rod by a holder and having tongs that clamp onto the laboratory equipment to hold it in place.



**gas burner**  
Device that is fueled by gas to produce a flame for heating chemical products.

**graduated cylinder**

Graduated tube with a spout that is used especially for measuring small amounts of liquid with precision.

**straight stopcock burette**

Long graduated tube for measuring liquids with high precision; it is fitted with a valve for manually regulating the flow.

**serological pipette**

Fine tube that is open at both ends; it is used to transfer very precise quantities of liquids from one container to another.

**Petri dish**

Flat transparent box for culturing microorganisms; it has a cover to protect them from contamination.

**test tube**

Cylindrical tube used to conduct various chemical experiments on small quantities (normally, it is not filled above one-third).



# chemistry symbols

Symbols that simplify the writing of the elements, formulas and chemical reactions.



## negative charge

Symbol that indicates a surplus of electrons in an atom, which means the atom has a negative electric charge. The chlorine atom, for example, forms a negative ion that is denoted as Cl<sup>-</sup>.



## positive charge

Symbol that indicates a loss of electrons in an atom, which means the atom has a positive electric charge. The sodium atom, for example, forms a positive ion that is denoted as Na<sup>+</sup>.



## reversible reaction

Chemical reaction that can occur in both directions; the products obtained (direct reaction) react between them to change back into the original reactants (inverse reaction).

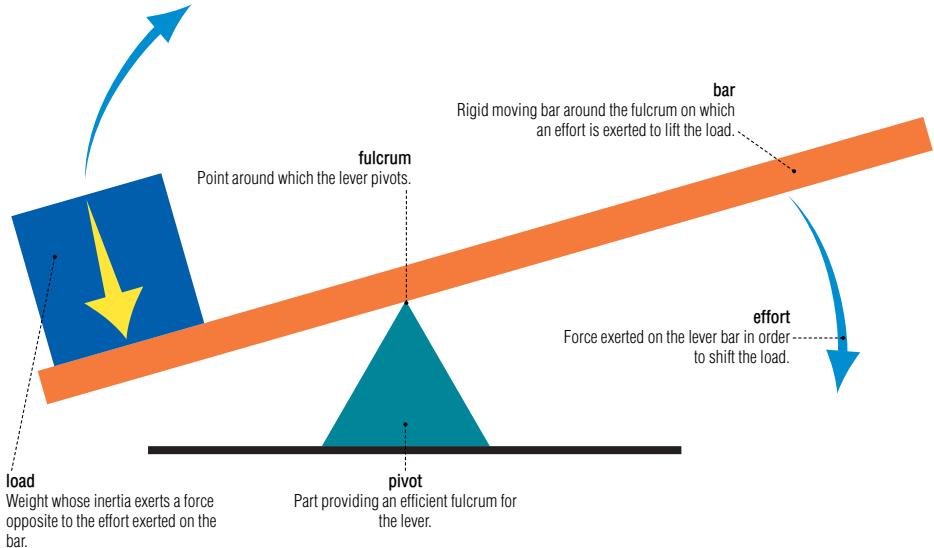


## reaction direction

A chemical reaction corresponds to the conversion of reactants in products and is obtained by the loss of one of the reactants. The arrow indicates the direction in which this irreversible reaction occurs.

# lever

System consisting of a bar pivoting on a fulcrum to lift a load. The amount of effort required is related to the position of the pivot and the length of the bar.

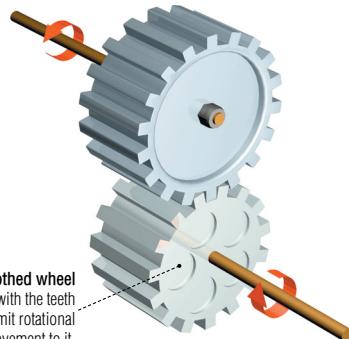


Mechanisms consisting of toothed parts that mesh to transmit the rotational motion of the shafts they are a part of.



**rack and pinion gear**

Gearing system converting a rotational movement into a horizontal movement (and vice versa); it is often used in the steering systems of automobiles.



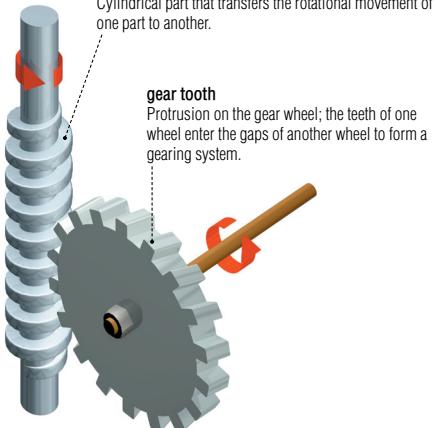
**toothed wheel**

Wheel with teeth that mesh with the teeth of another wheel to transmit rotational movement to it.

**spur gear**

Most common gearing system linking two parallel shafts that changes the speed and force of a rotation; it is used especially in automobile transmissions.

**shaft**  
Cylindrical part that transfers the rotational movement of one part to another.



**worm gear**

One-way gearing system (only the screw can drive the wheel) for slowing down the speed of rotation between two perpendicular axles; it is used especially in the automobile industry (Torsen differential).

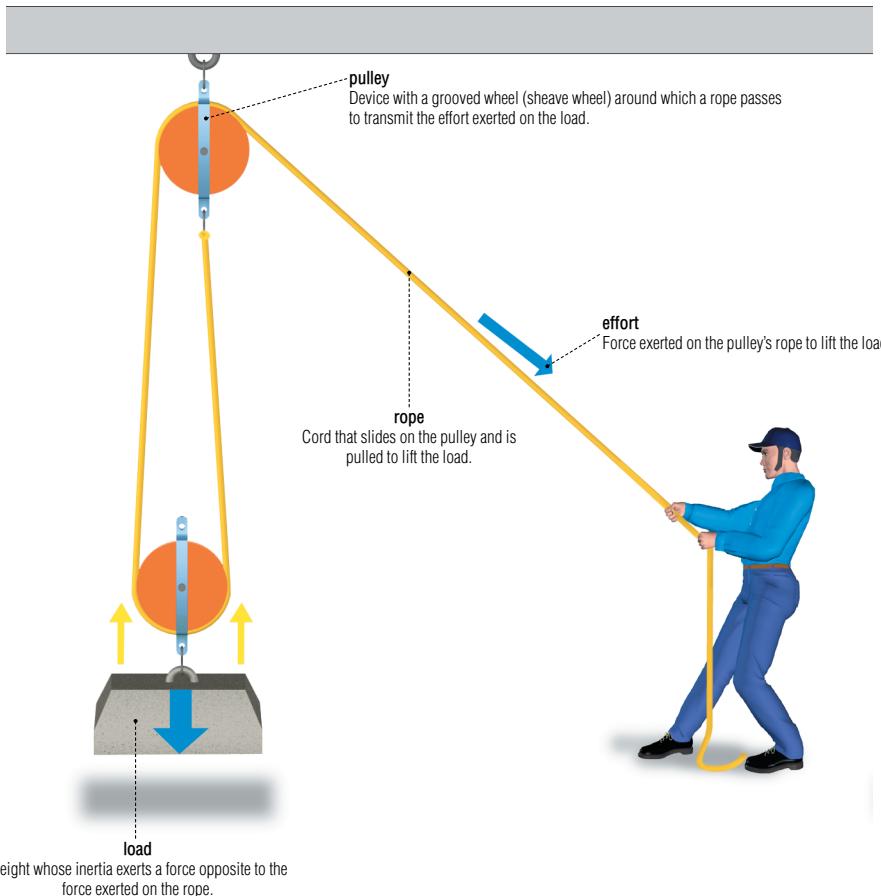


**bevel gear**

Gearing system linking two shafts at right angles that changes the direction of rotation; it is used especially in car jacks.

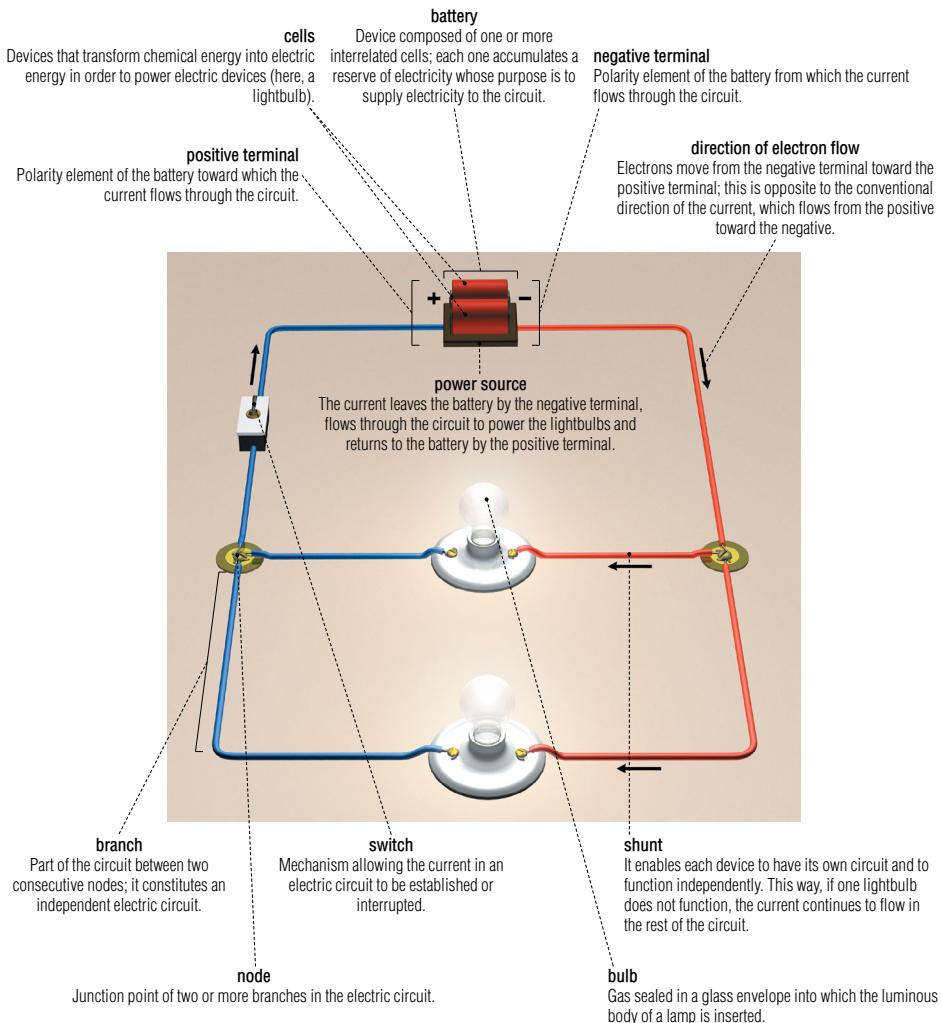
## double pulley system

System consisting of two pulleys with a rope running around them to lift a load. Using two or more pulleys reduces the amount of effort needed.



## parallel electrical circuit

It is divided into independent branches, through which the current flows with partial intensity (in a series circuit, all the elements receive the same intensity).

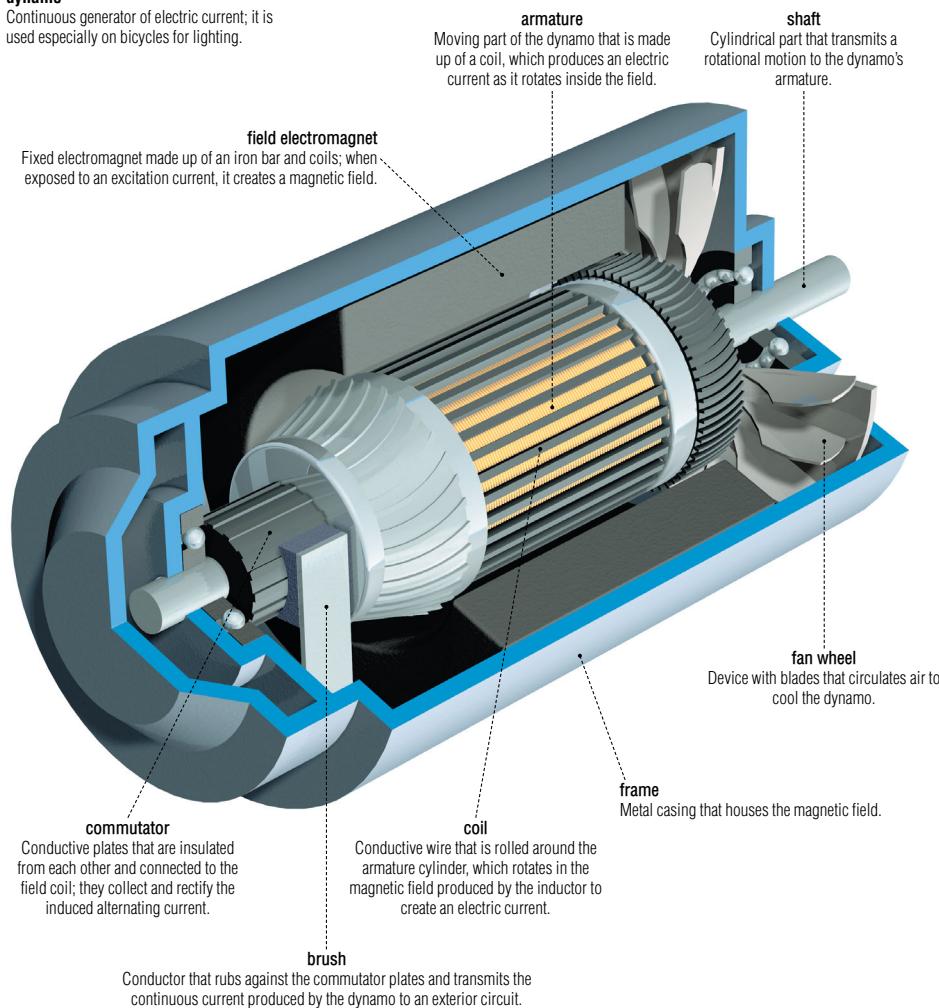


## generators

Devices that convert mechanical energy (here, a shaft's rotational motion) into electric energy by moving a coil inside a magnet (electromagnetic induction).

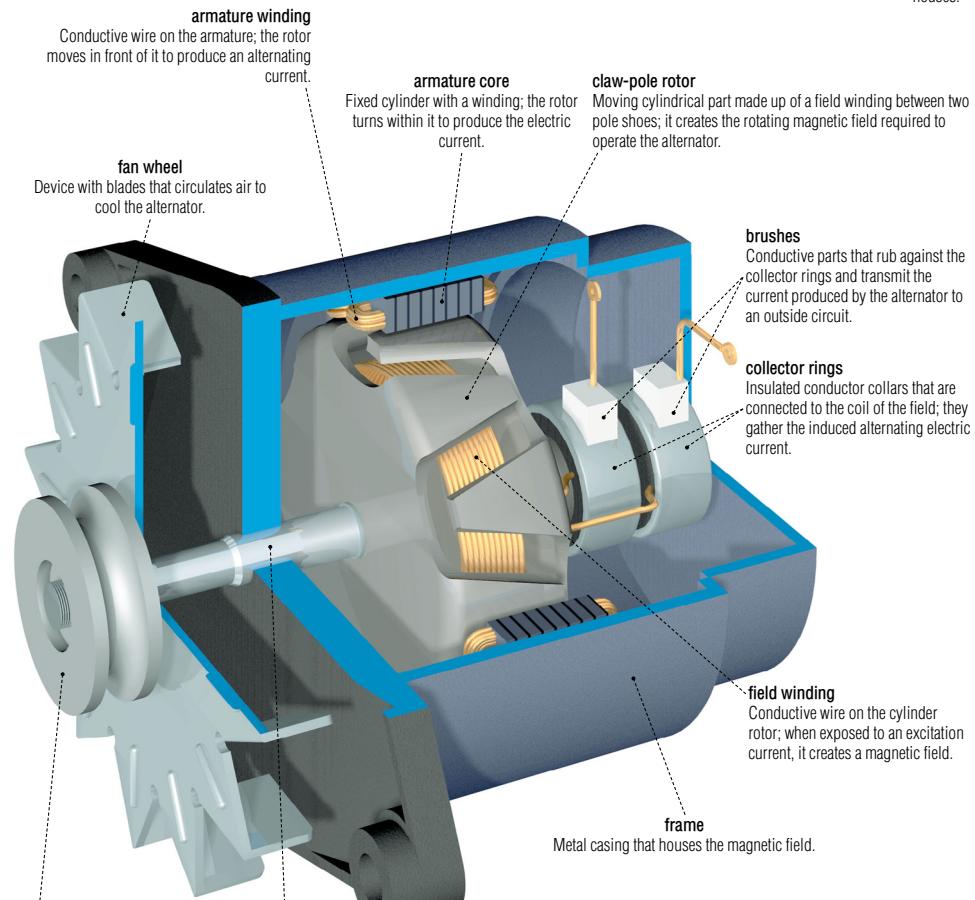
### dynamo

Continuous generator of electric current; it is used especially on bicycles for lighting.



**alternator**

Generator of alternating current that is used especially in the automobile industry (powering electrical devices) and in power houses.

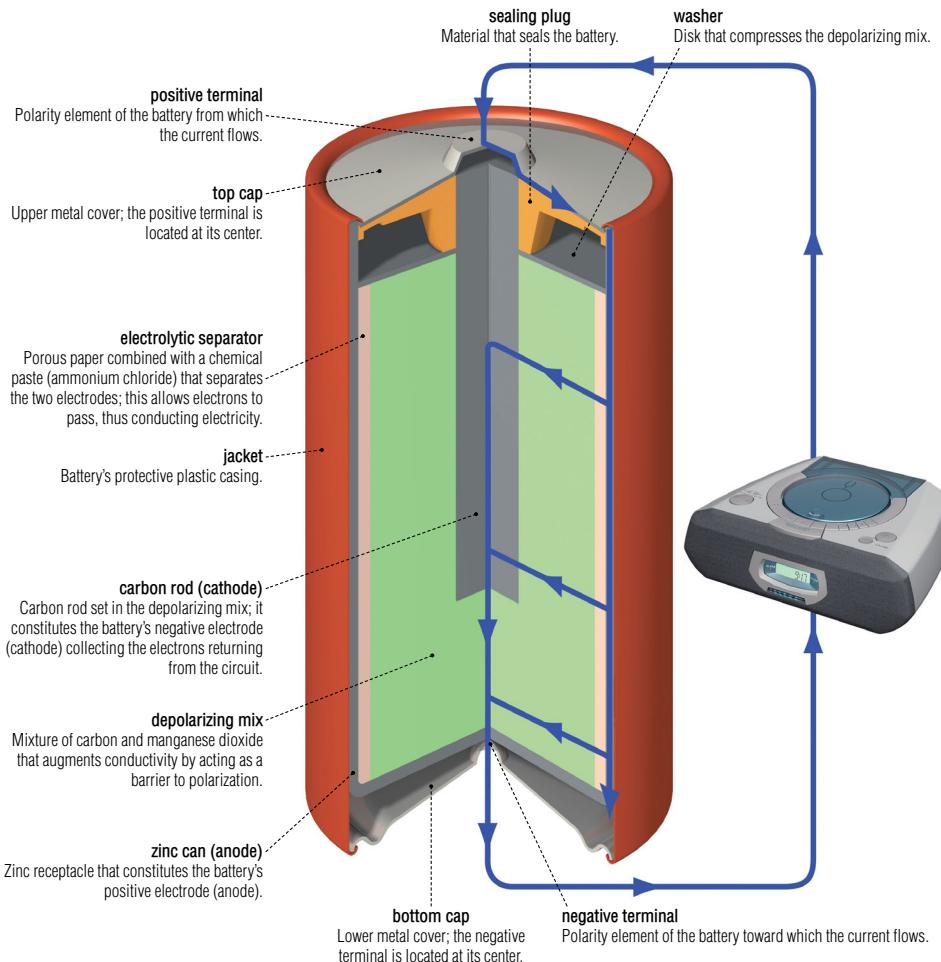


# dry cells

Devices that transform chemical energy into electric energy (direct current); they usually cannot be recharged and the electrolyte is fixed in place.

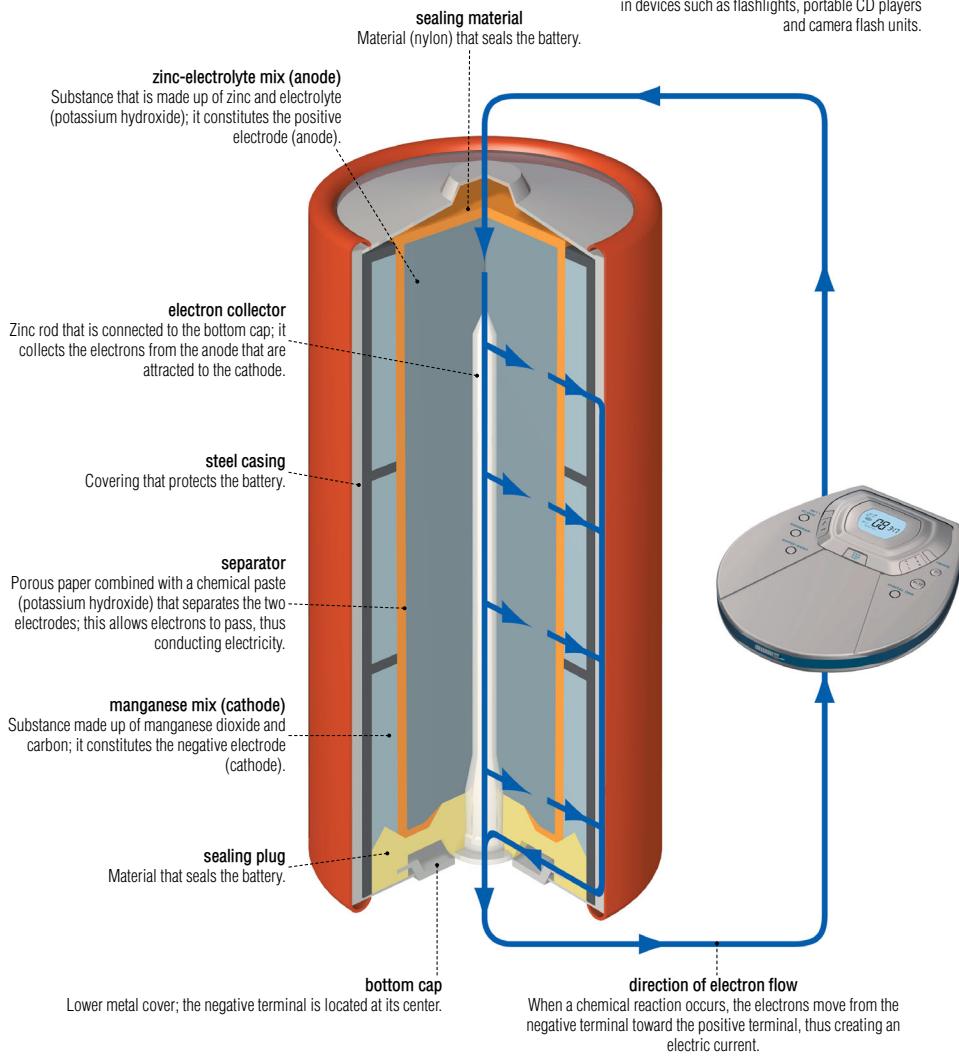
## carbon-zinc cell

Battery that produces 1.5 V (also called Leclanché); its use is very widespread (pocket calculators, portable radios, alarm clocks).



**alkaline manganese-zinc cell**

High-performance battery that produces 1.5 V and has a longer life span than the carbon-zinc cell; it is used in devices such as flashlights, portable CD players and camera flash units.



# electronics

The scientific study of the behavior of the electron and its applications, such as computers, medicine and automation.

## printed circuit board

Usually plastic insulated card with holes containing electronic components; the circuit is printed on its surface.

## ceramic capacitor

Component with two conductive plates (silver, copper) separated by an insulator (ceramic); it stores weak electric charge.

## plastic film capacitor

Commonly used component with two conductive plates (aluminum, tin) separated by an insulator (plastic); it stores electric charge.

## electrolytic capacitors

Polarized components with two conductive components (aluminum, tantalum) separated by an insulator (electrolyte); they store strong electric charge.

## packaged integrated circuit

Electric circuit under a plastic or ceramic casing; it has pins for connecting it to the circuit board.

## printed circuit

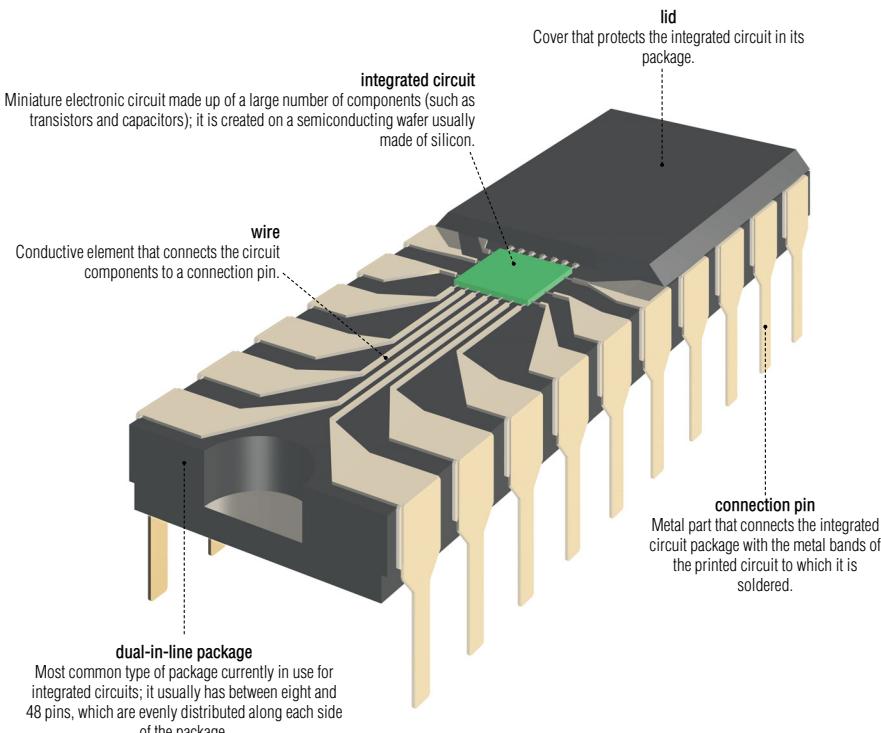
All of the conductive metal bands on an insulated base (card), which connect a circuit's components and allow a current to flow through it.

## resistors

Electronic component that regulates the amount of current flowing in a circuit.

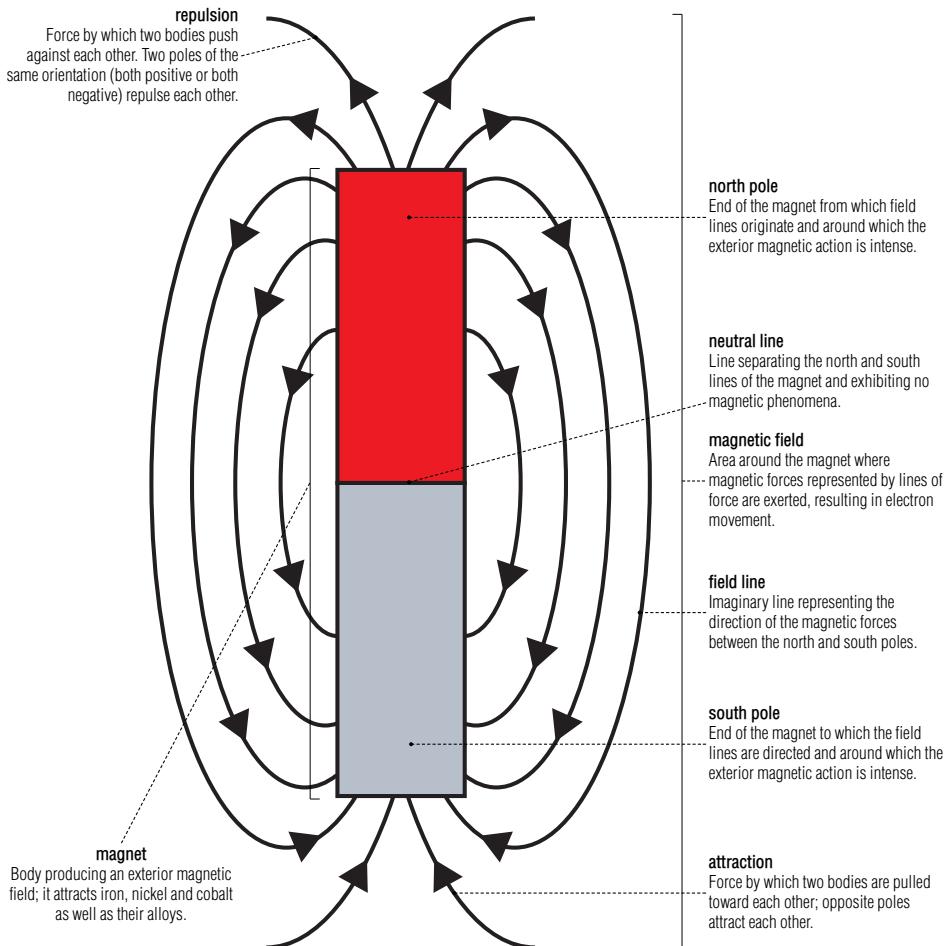
**packaged integrated circuit**

Integrated circuits are used especially in microprocessors, stereo equipment, calculators, watches and electronic games.

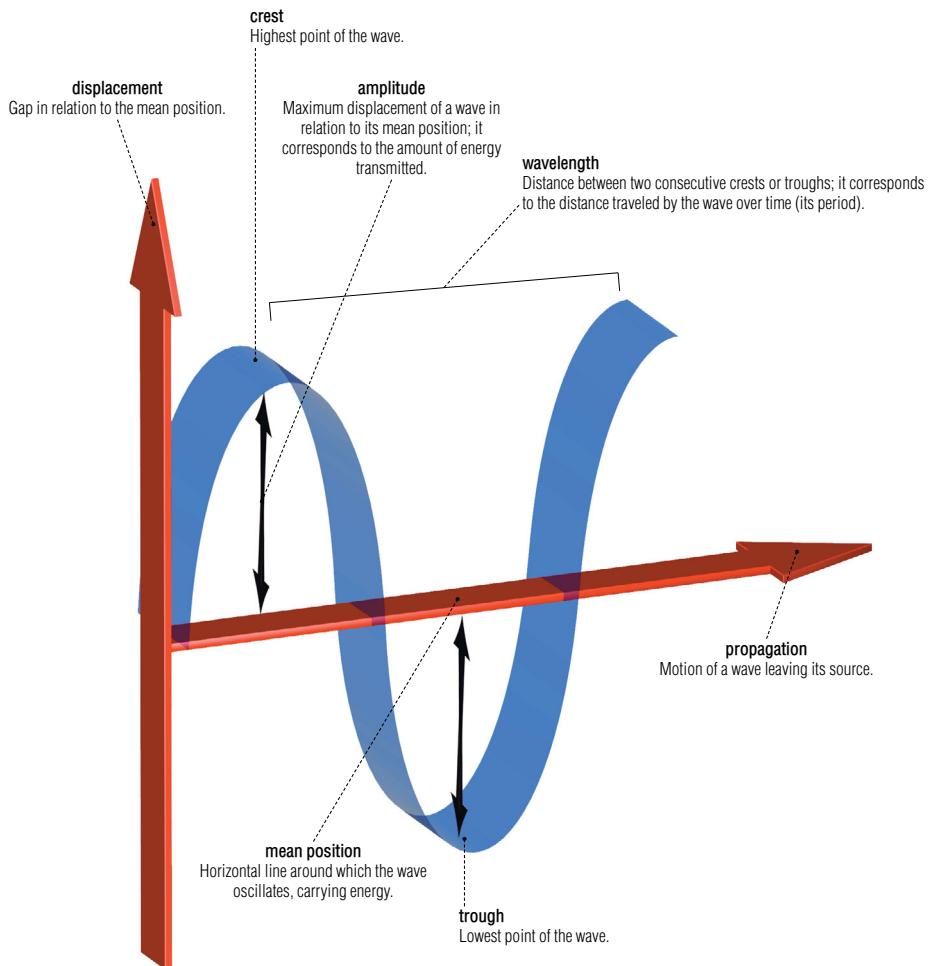


# magnetism

Action exerted by magnets and magnetic fields and phenomena. Magnetism can be characterized by the forces of attraction and repulsion between two masses.



Oscillation caused by a disturbance; as it propagates through a medium (mechanical waves) or a vacuum (electromagnetic waves), it carries energy.



## electromagnetic spectrum

Electromagnetic waves that are classified in ascending order of energy (frequency); they propagate at the speed of light (300,000 km/s).

### radio waves

Very long electromagnetic waves (about 1 meter) having low frequency; they are used to transmit information (television, radio).

### ultraviolet radiation

Electromagnetic waves used especially to tan skin and in microscopy, medicine and lighting (fluorescent tubes).

### infrared radiation

Electromagnetic waves emitted by warm objects; their many uses include heating, medicine, aerial photography and weaponry.

### gamma rays

Electromagnetic waves of very high frequency that are emitted by radioactive bodies; they are the most radiant and harmful rays and are used especially in treating cancer.

### microwaves

Very short electromagnetic waves; their many applications include radar detection and microwave ovens.

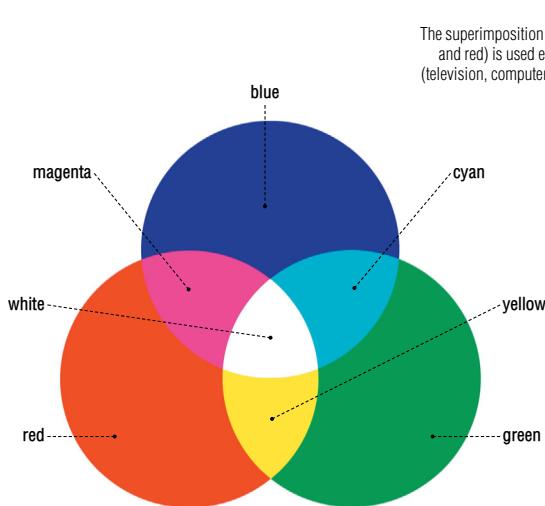
### visible light

Electromagnetic radiation that is perceived by the human eye and ranges from red to violet.

### X-rays

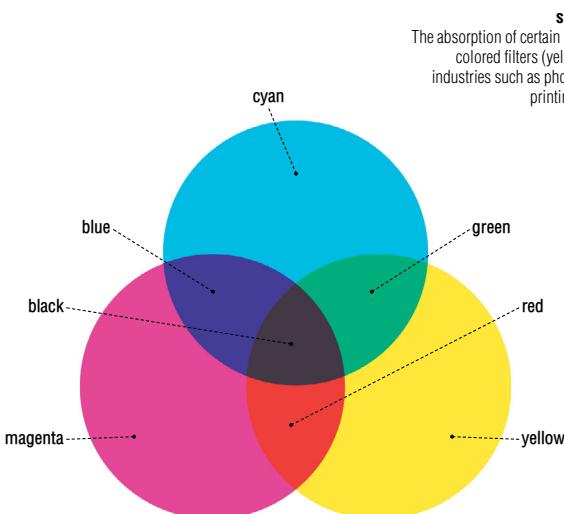
Electromagnetic waves used especially in radiology; frequent exposure can be harmful.

Technique of generating color by combining light rays or subtracting them to obtain a colored image.



#### **additive color synthesis**

The superimposition of primary colors (blue, green and red) is used especially in electronic screens (television, computer, video) to obtain intermediate tints.



#### **subtractive color synthesis**

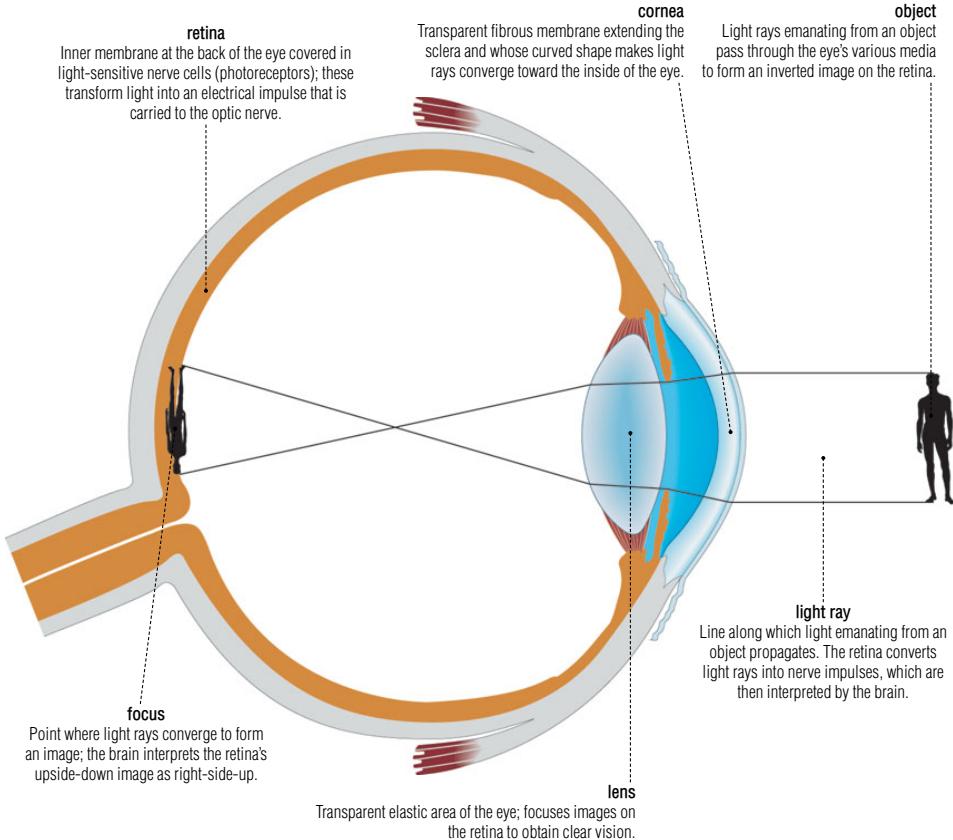
The absorption of certain light rays (blue, green, red) by colored filters (yellow, magenta, cyan) is used in industries such as photography, film production and printing to obtain intermediate tints.

# vision

Ability to perceive shapes, distances, motion and colors; it is related to light rays and varies depending on the degree of sensitivity of the eye.

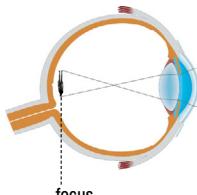
## normal vision

The image of an object is formed on the retina after passing through the lens, which, depending on the distance of the object, expands or contracts to give a sharp image.



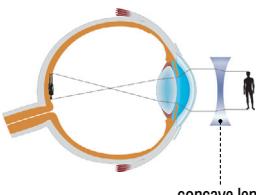
**vision defects**

Images do not form on the retina, thus resulting in blurry vision; such defects are corrected by eyeglasses, contact lenses or even surgery.



focus

Point where light rays converge to form an image; the brain interprets the retina's upside-down image as right-side-up.

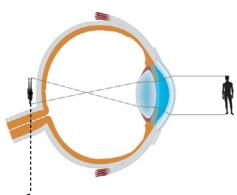


concave lens

Corrects myopia by causing light rays emanating from an object to diverge and project an image onto the focus of the retina.

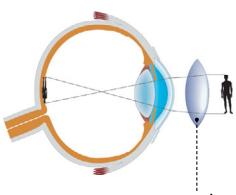
**myopia**

The image of a distant object is formed in front of the retina due to a defect in the light rays' convergence. This makes distant objects hard to see.



focus

Point where light rays converge to form an image; the brain interprets the retina's upside-down image as right-side-up.

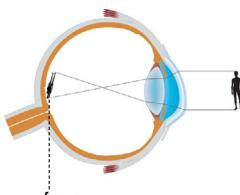


convex lens

Corrects hyperopia by causing light rays emanating from an object to converge and project an image onto the focus of the retina.

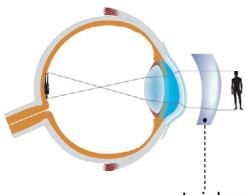
**hyperopia**

The image of an object is formed behind the retina due to a defect in the light rays' convergence as they pass through the lens. This makes near objects hard to see.



focus

Point where light rays converge to form an image; the brain interprets the retina's upside-down image as right-side-up.



toric lens

Has various powers depending on the rays' axes of convergence; it is used to offset the visual distortion caused by the cornea.

**astigmatism**

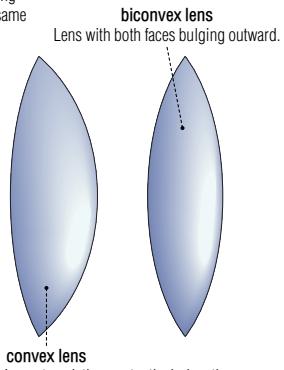
Usually caused by a curvature of the cornea, it is manifested by blurred vision when viewing both near and far objects, depending on various axes.

# lenses

Transparent pieces of material (usually glass) that cause light rays to converge or diverge to form a sharp image (eyeglasses, microscopes, telescopes, cameras).

## converging lenses

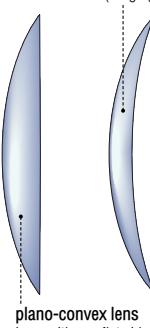
Thicker in the center than on the edges; they cause parallel light rays emanating from an object to converge onto the same point.



**convex lens**  
Lens with one side bulging outward; the greater the bulge, the more the light rays converge.

## positive meniscus

Lens where the concave side (curving inward) is less pronounced than the convex side (bulging outward).

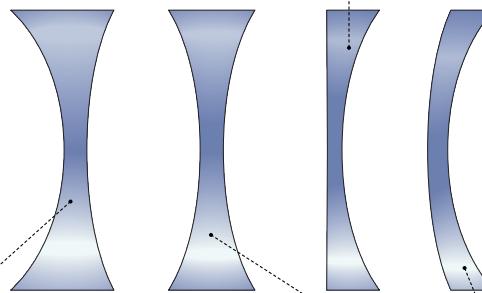


**piano-convex lens**

Lens with one flat side and one convex side (bulging outward).

## diverging lenses

Thicker on the edges than in the center; they cause parallel light rays emanating from an object to diverge.



**concave lens**  
Lens with one side curving inward; the greater the curvature, the more the light rays diverge.

## plano-concave lens

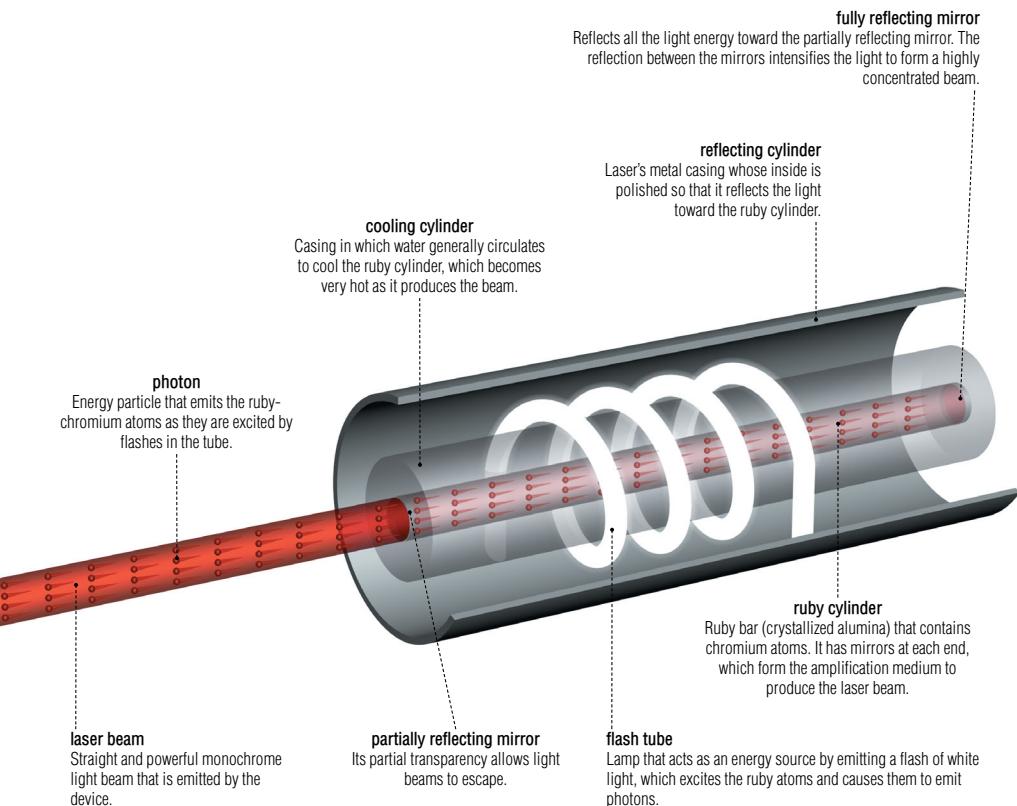
Lens with one flat side and one concave side (curving inward).

**biconcave lens**  
Lens with both sides curving inward.

**negative meniscus**  
Lens where the concave side (curving inward) is more pronounced than the convex side (bulging outward).

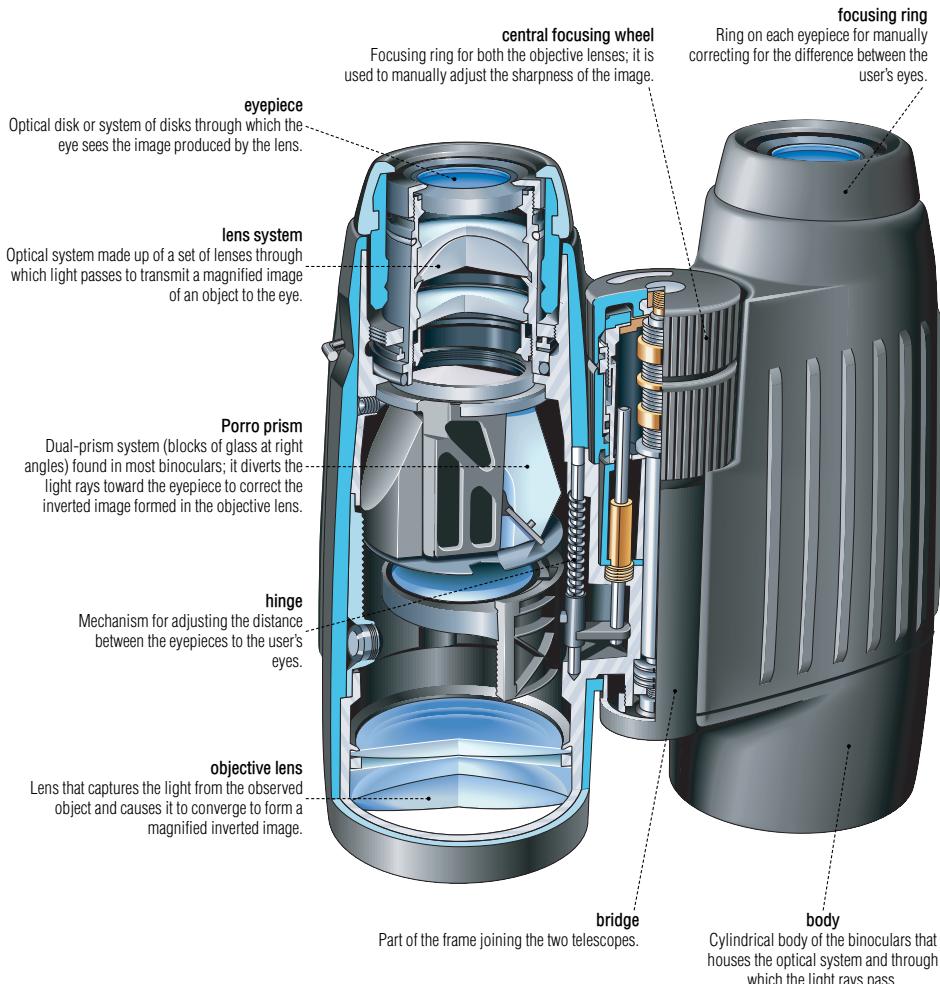
# pulsed ruby laser

Device that produces a thin and very intense colored light beam; its various applications include fiber optics, manufacturing and surgery.



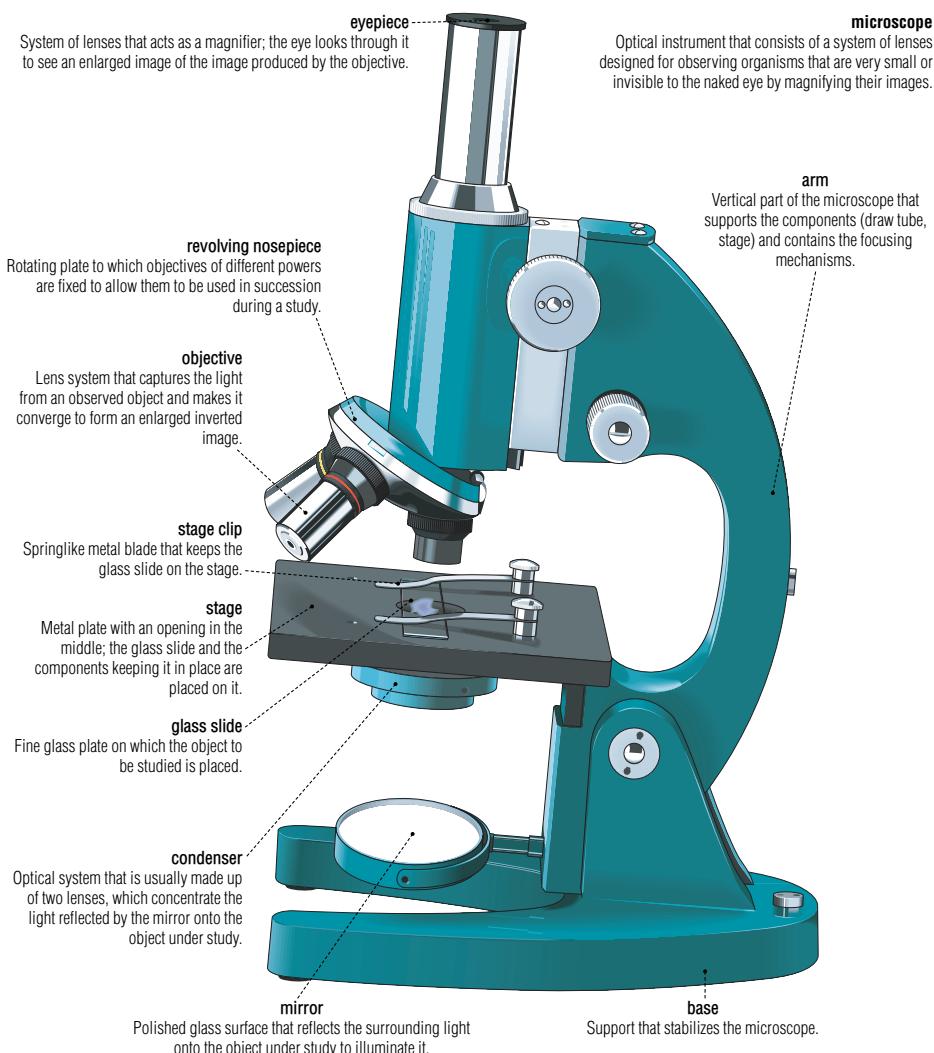
## prism binoculars

Optical instrument made up of two identical telescopes, one for each eye; it magnifies both near and distant objects.



# magnifying glass and microscopes

Optical instruments used to magnify the image of a near object; they range in strength from low (magnifying glass) to strong (microscope).



## magnifying glass and microscopes

**binocular microscope**

Its two eyepieces allow both eyes to be fully applied; this provides a degree of depth to the image and prevents eyestrain.

**limb top**

Upper part of the arm that supports the revolving nosepiece.

**objective**

Lens system that captures the light from the observed object and makes it converge to form an enlarged inverted image.

**stage clip**

Springlike metal blade that keeps the glass slide on the stage.

**glass slide**

Fine glass plate on which the object to be studied is placed.

**condenser adjustment knob**

Screw that centers the condenser's light beam in the field of vision by moving it along a horizontal plane.

**base**

Support that stabilizes the microscope.

**eyepiece**

System of lenses that acts as a magnifier; the eye looks through it to see an enlarged image of the image produced by the objective.

**draw tube**

One of two cylindrical tubes that house the eyepieces; it is often made up of two converging lenses.

**revolving nosepiece**

Rotating plate to which objectives of different powers are fixed to allow them to be used in succession during a study.

**field lens adjustment**

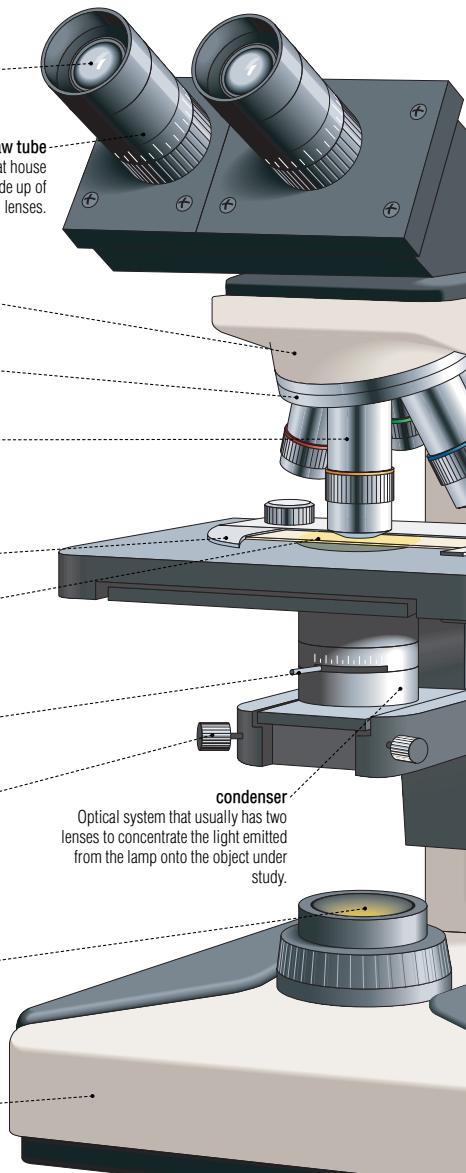
Device with a variable-diameter opening that adjusts the amount of light illuminating the object.

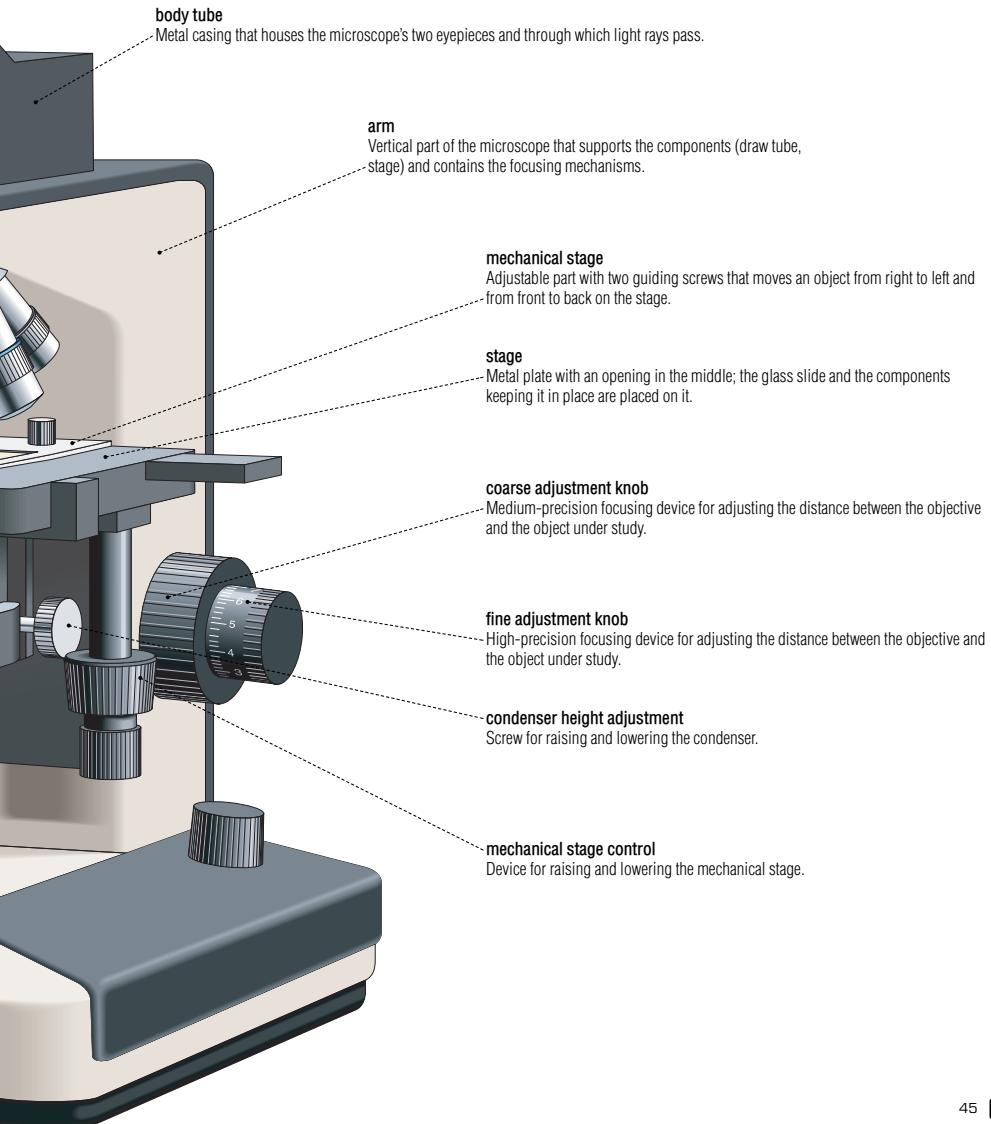
**lamp**

Electric device that produces a light beam to illuminate the object under study.

**condenser**

Optical system that usually has two lenses to concentrate the light emitted from the lamp onto the object under study.

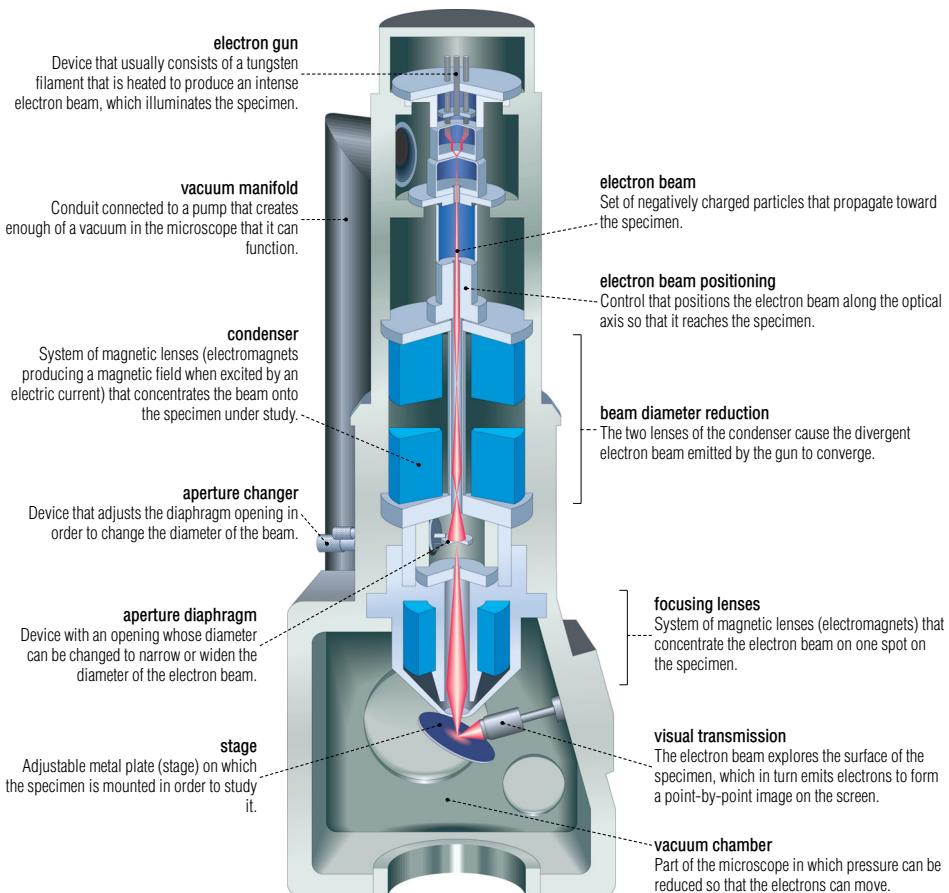


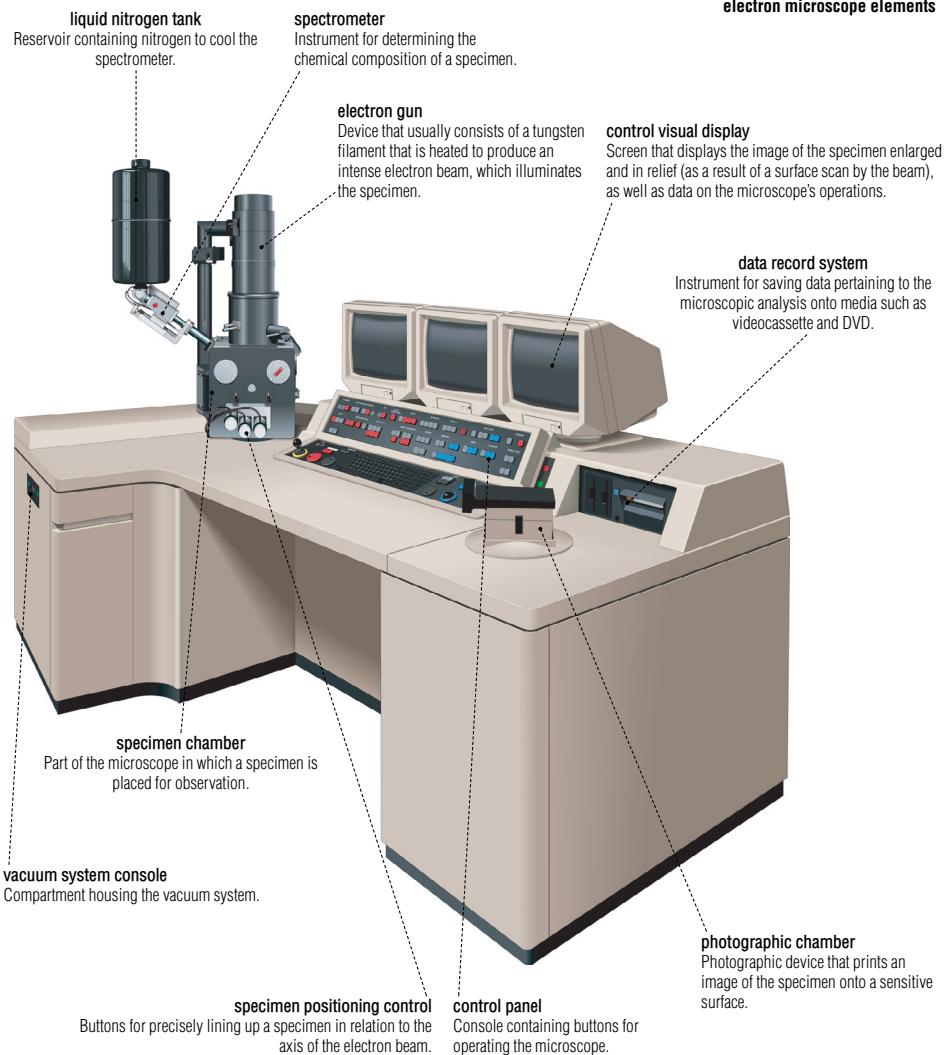


## magnifying glass and microscopes

**cross section of an electron microscope**

Electron microscope: it uses an electron beam (as opposed to light) to provide magnification that is markedly superior to that of an optical microscope.

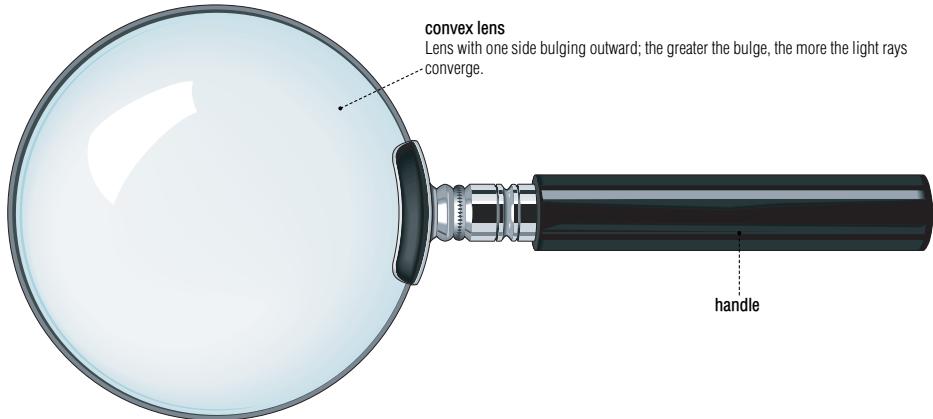




## magnifying glass and microscopes

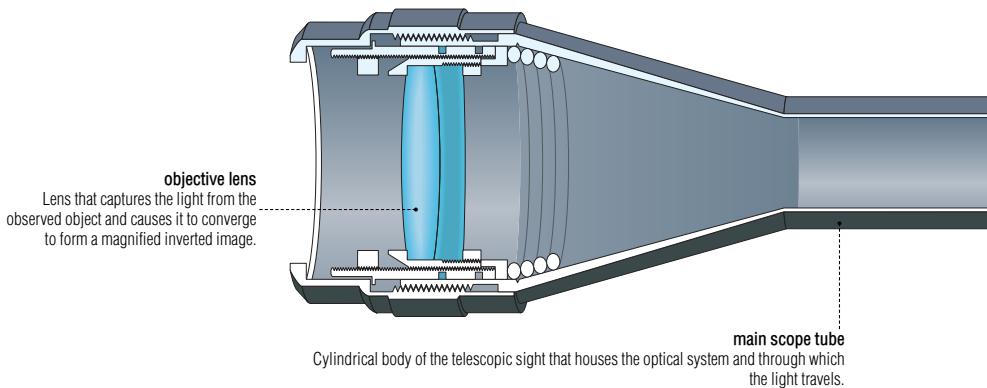
### magnifying glass

Converging lens that magnifies the image of an object.



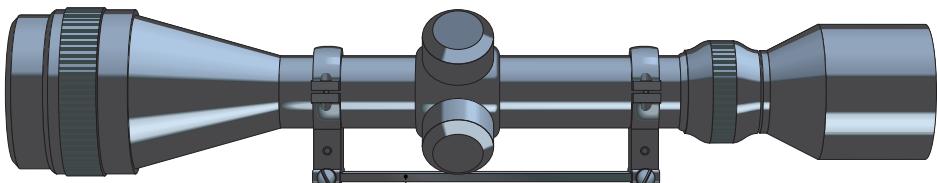
### telescopic sight

Optical instrument mounted on a rifle or a measuring device to increase accuracy.



**objective lens**  
Lens that captures the light from the observed object and causes it to converge to form a magnified inverted image.

**main scope tube**  
Cylindrical body of the telescopic sight that houses the optical system and through which the light travels.

**dovetail**

Device for mounting the telescopic sight onto a device or firearm.

**elevation adjustment**

Button for positioning the sight vertically to offset any divergence of the target from the reticle.

**erecting lenses**

Lens system that returns the inverted image formed on the objective lens.

**turret cap**

Part covering and protecting an adjustment button.

**field lens**

Lens placed between the objective and the eyepiece to widen the field of vision.

**eyepiece**

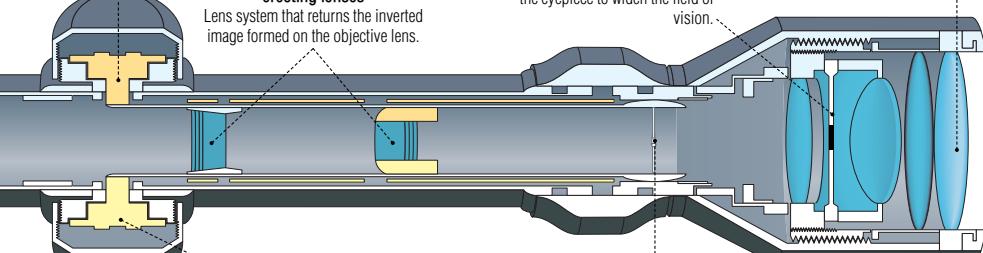
Optical disk or system of disks through which the eye sees the image produced by the lens.

**reticle**

Optical system made up of two fine crossed wires to create a precise point as a sighting reference.

**winding adjustment**

Button for positioning the sight horizontally to offset any divergence of the target from the reticle.



# reflecting telescope

Optical instrument that uses an objective mirror to observe celestial bodies.



## refracting telescope

Optical instrument that uses an objective lens to observe celestial bodies.

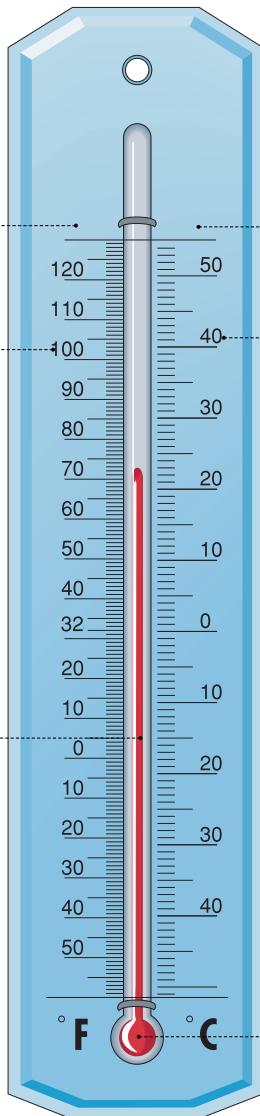


## measure of temperature

Temperature: physical quantity corresponding to the level of heat or cold, which is measured by means of a thermometer.

### thermometer

Instrument for measuring temperature by means of a substance (usually a liquid or a gas) contained in a graduated tube.



### Fahrenheit scale

Temperature scale that is used in some English-speaking countries, on which the freezing point of water is at 32 and the boiling point at 212.

### Celsius scale

Temperature scale that is based on a graduation from 0 (freezing point of water) to 100 (boiling point of water); it was formerly called the centigrade scale.

### F degrees

Symbol representing a unit of measurement on the Fahrenheit scale (Fahrenheit degree).

### C degrees

Symbol representing a unit of measurement on the Celsius scale (Celsius degree).

### alcohol column

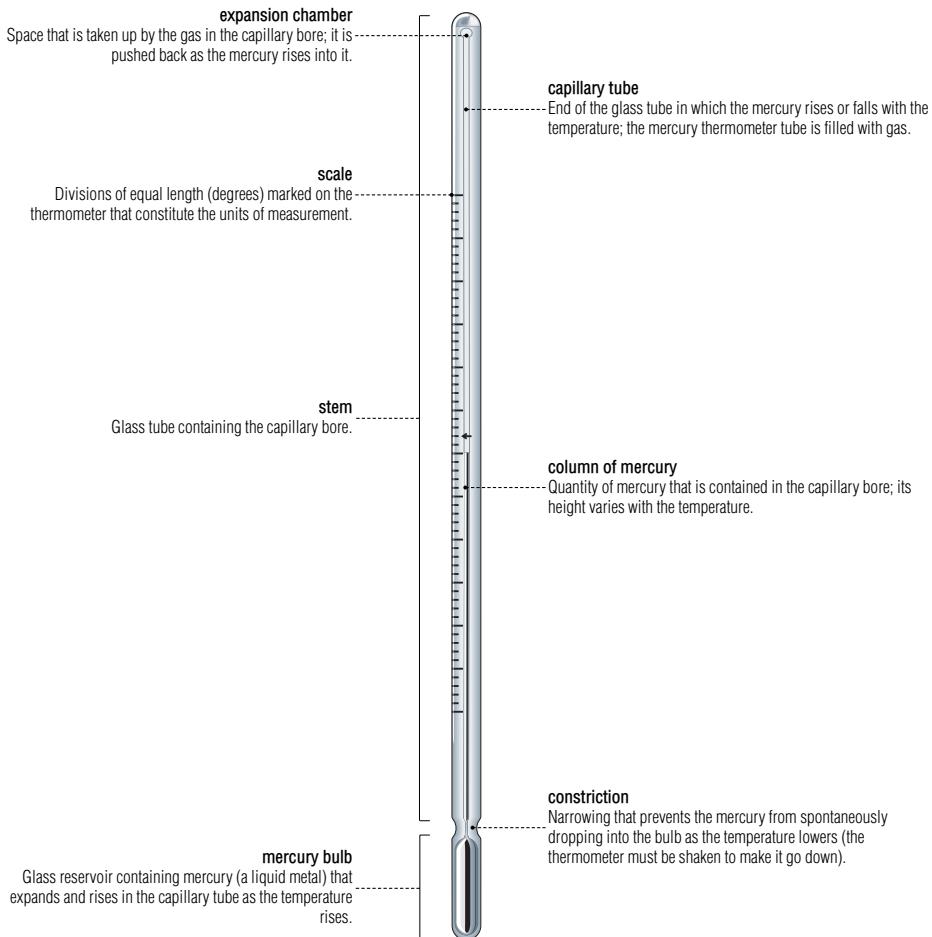
Quantity of alcohol that is contained in the glass tube; its height varies with the temperature.

### alcohol bulb

Glass reservoir containing colored alcohol (methanol, ethanol) that expands and rises in the capillary bore as the temperature rises.

**clinical thermometer**

More precise than the alcohol thermometer, it is used to take the temperature of the human body; it is graduated from 94°F to 108°F.



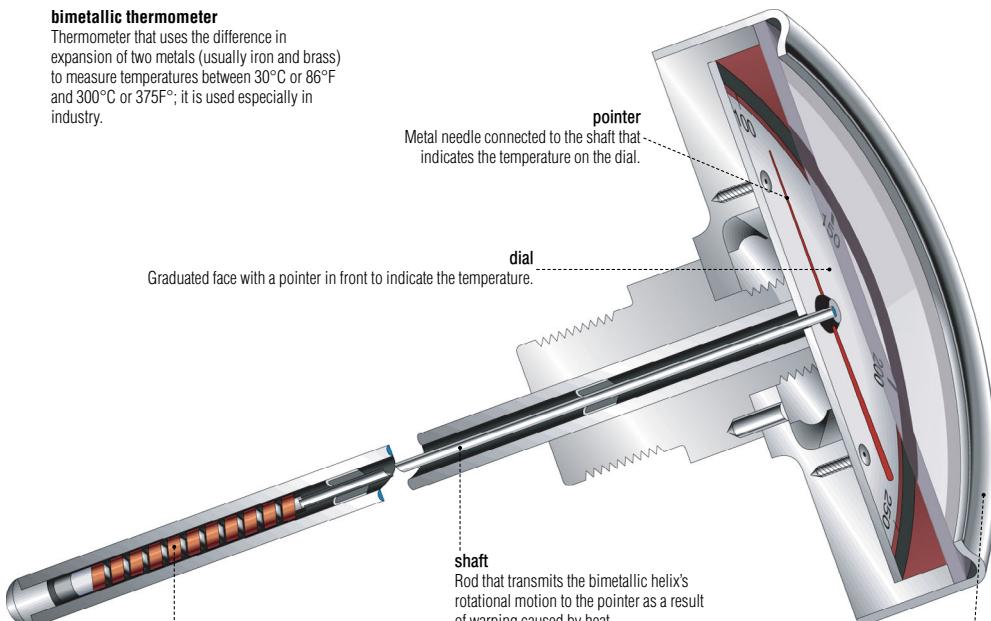
## measure of temperature

**digital thermometer**

Thermometer that indicates the temperature in digits on a liquid crystal display screen.

**bimetallic thermometer**

Thermometer that uses the difference in expansion of two metals (usually iron and brass) to measure temperatures between 30°C or 86°F and 300°C or 375°F; it is used especially in industry.

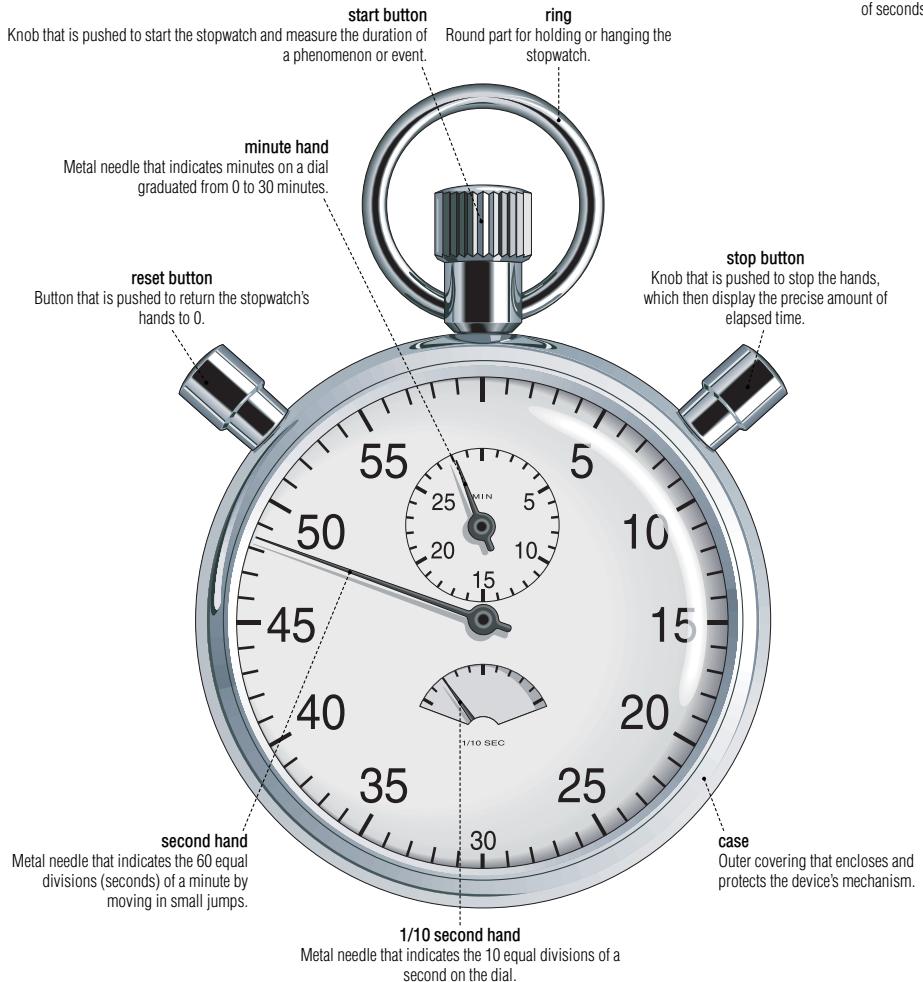
**bimetallic helix**

Band made by welding together two metals with different coefficients of expansion; it curves as the temperature changes.

Time: physical quantity corresponding to a phenomenon or an event that is measured with devices such as watches and stopwatches.

**stopwatch**

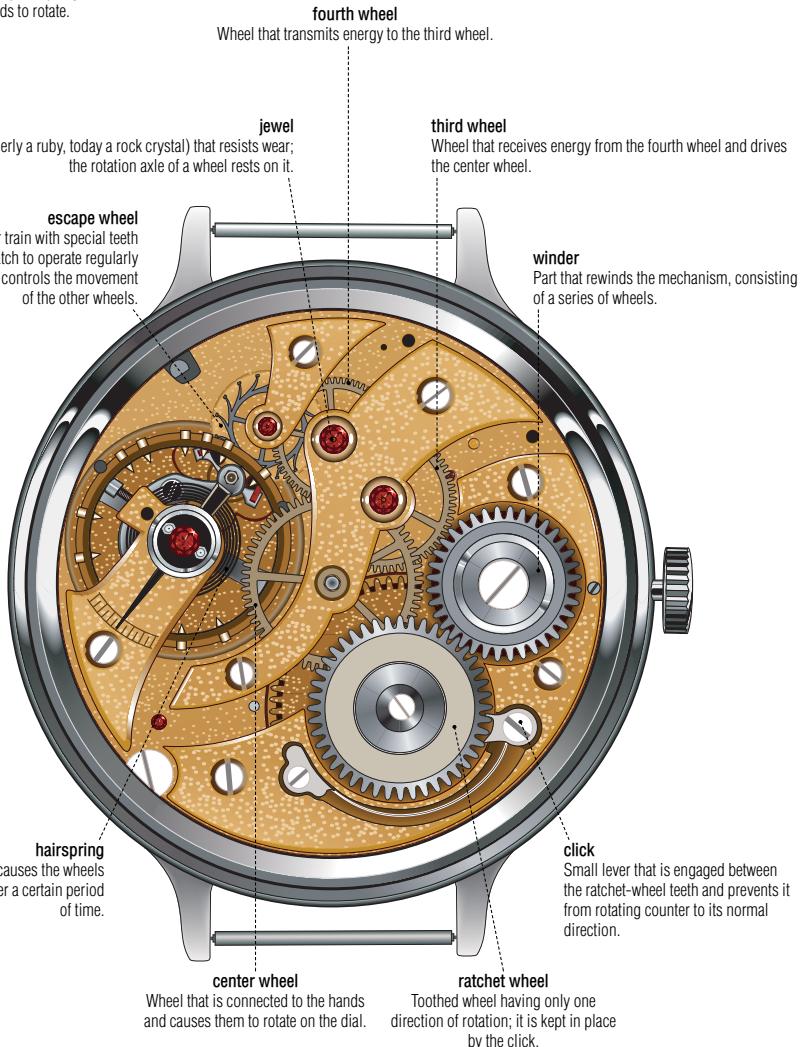
Instrument that precisely measures time in minutes, seconds and fractions of seconds.



## measure of time

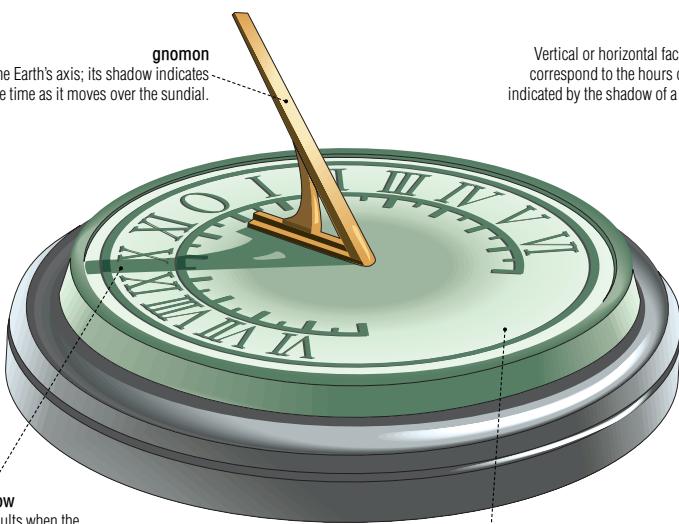
**mechanical watch**

Set of geared wheels that reduce the force transmitted by a spiral spring to cause the watch's hands to rotate.



**sundial**

Vertical or horizontal face with divisions that correspond to the hours of the day, which are indicated by the shadow of a gnomon cast by the Sun.



**shadow**  
Dark area that results when the gnomon blocks the sunlight and indicates the time in accordance with the position of the Sun.

**dial**  
Face marked with numbers over which shadows are cast by the gnomon to indicate the approximate time of day.

**analog watch**

The time is displayed by hands, which move around the dial.

**digital watch**

The time is read from letters and numbers that appear on a clear background.

**liquid crystal display**

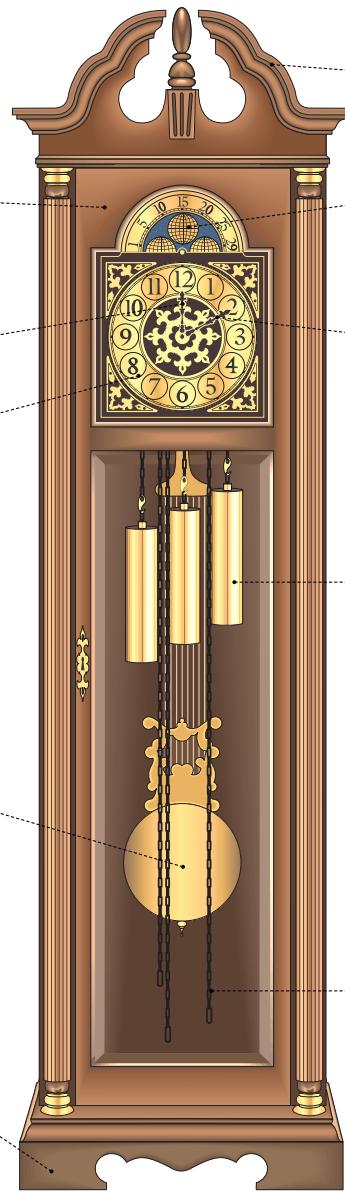


**crown**  
Knob with sprockets that is connected to the winder; it is used to manually wind the watch and set its time.

## measure of time

**grandfather clock**

Clock with a pendulum that is operated by weights and housed in a tall (usually over 2 m high) straight body, which stands upright on the floor.

**pediment**

Set of decorative moldings that surmount the clock.

**Moon dial**

Face divided into 29 1/2 days that is represented by a moon whose movement indicates the phases of the Moon: first quarter, full moon, last quarter, new moon.

**minute hand**

Metal needle that points at the 60 minutes of an hour on the dial.

**body**

Usually wooden box that houses and protects the clock's mechanism.

**hour hand**

Metal needle that points at the 24 hours of a day on the dial.

**dial**

Graduated face over which the hands move to indicate the time.

**weight**

Heavy body that hangs from the main wheel; its descent provides the necessary energy for the clock's mechanism.

**pendulum**

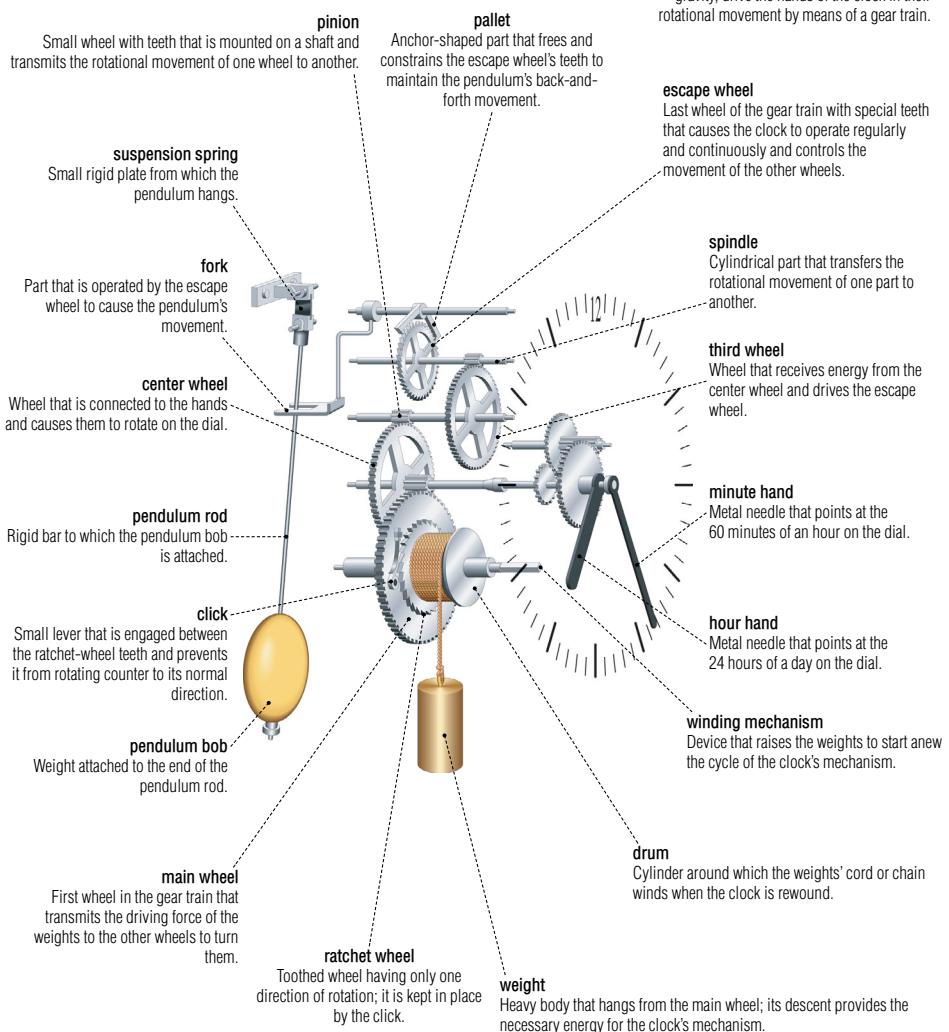
Unit whose regular swinging motion controls the workings of the clock's mechanism.

**chain**

Series of interlaced rings to which weights are attached.

**plinth**

Base that supports the clock and makes it stable.

**weight-driven clock mechanism**

This clock is operated by weights that, under gravity, drive the hands of the clock in their rotational movement by means of a gear train.

**escape wheel**

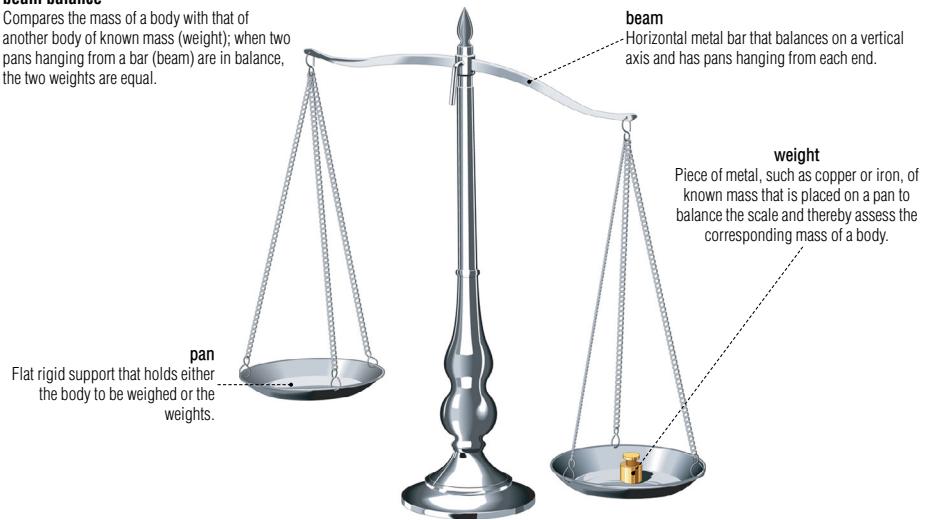
Last wheel of the gear train with special teeth that causes the clock to operate regularly and continuously and controls the movement of the other wheels.

## measure of weight

Mass: physical quantity that characterizes an amount of matter (mass) that is measured by means of a scale.

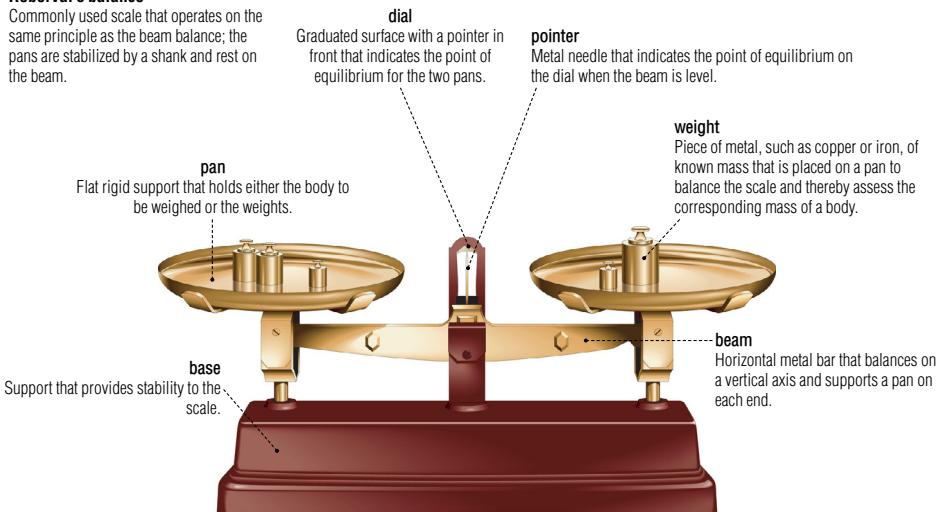
### beam balance

Compares the mass of a body with that of another body of known mass (weight); when two pans hanging from a bar (beam) are in balance, the two weights are equal.



### Roberval's balance

Commonly used scale that operates on the same principle as the beam balance; the pans are stabilized by a shank and rest on the beam.



**steelyard**

Scale used for weighing loads that has a beam with arms of different lengths; the shorter arm supports the pan and the longer arm supports the weights that slide to attain a balance.

**notch**

Groove in which a sliding weight catches so that a precise reading on the graduated scale can be taken.

**sliding weight**

Sliding part that is moved along the beams until a balance between the two masses is attained.

**pan hook**

Curved part from which the pan is hung by means of rods.

**magnetic damping system**

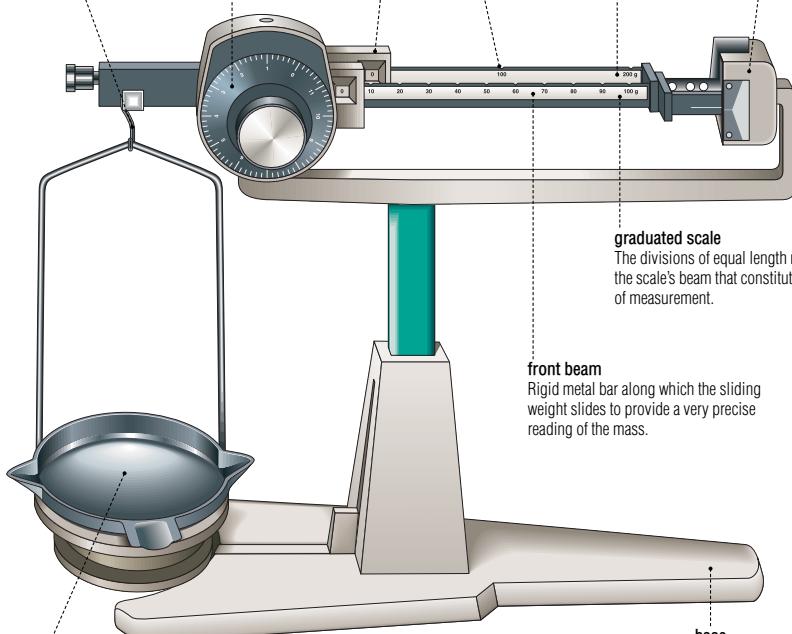
Device made up of magnets that reduce the beams' oscillations when the weights are moved to provide a quick reading of the mass.

**rear beam**

Rigid metal bar along which the sliding weight slides to provide a relatively precise reading of the mass.

**vernier**

Small graduated dial that slides along the beams and provides a very precise reading of the mass.

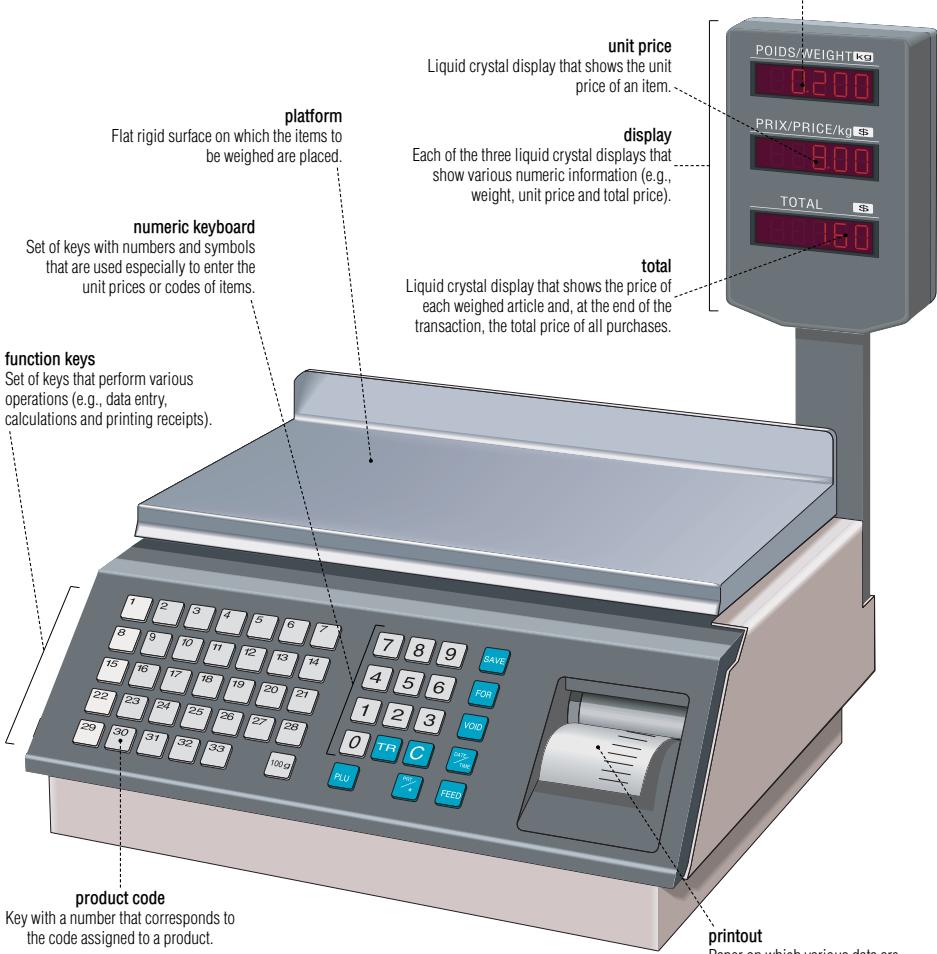


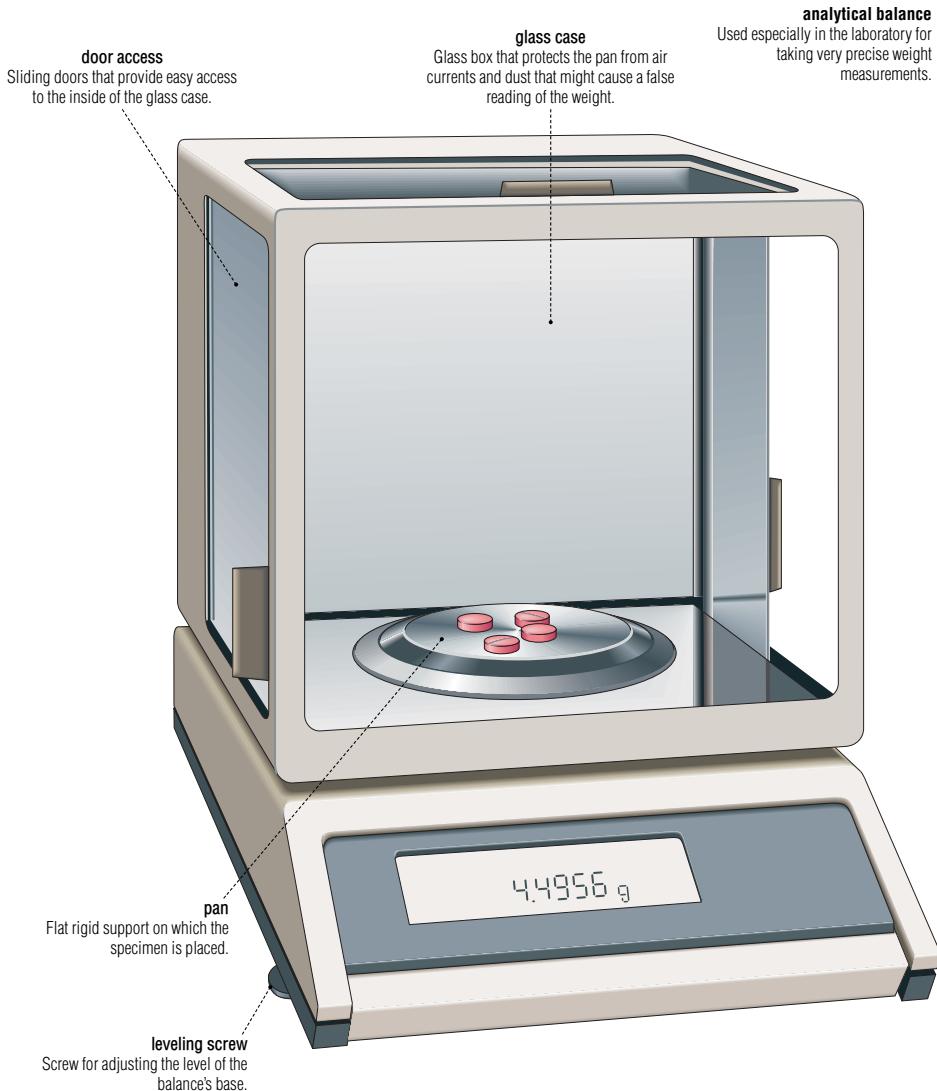
Flat rigid stand on which the body to be weighed is placed.

## measure of weight

**electronic scale**

Commercial scale that weighs and calculates the price of a quantity of merchandise and displays these elements.





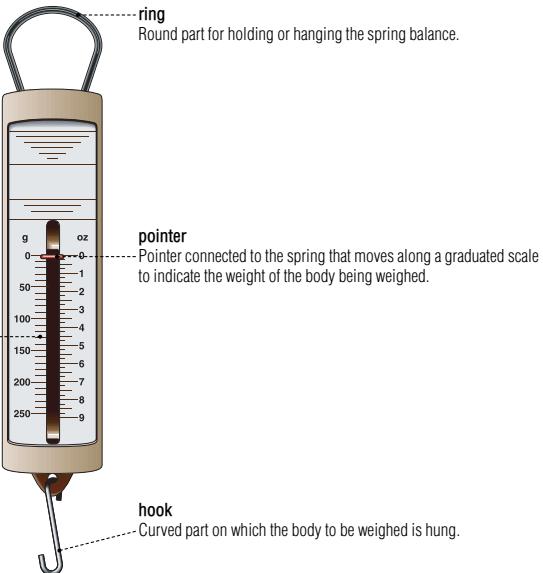
## MEASURING DEVICES

### measure of weight

#### spring balance

Scale made up of a hook attached to a spring that stretches in proportion to the weight of the object being weighed.

**graduated scale**  
The divisions of equal length that are marked on the spring balance and constitute the units of measurement.



#### bathroom scale

Scale used for weighing a person; it has a spring mechanism that compresses in proportion to the weight.

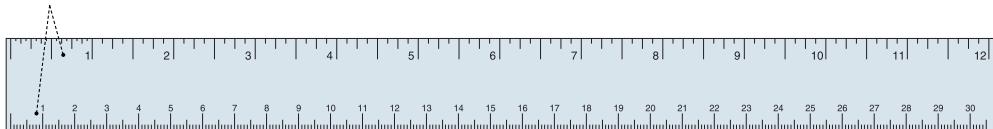


**measure of length**

Length: the longer dimension of an object as opposed to its width.

**scale**

The divisions of equal length that are marked on the ruler and constitute the units of measurement.

**ruler**

Instrument for measuring length.

**measure of distance**

Distance: interval separating two points in space.

**distance traveled**

Number of steps taken by the walker or runner converted into miles.

**pedometer**

Device that counts the number of steps taken by a walker or runner to measure the distance traveled.

**clip**

Metal fastener for attaching the pedometer to a belt or article of clothing.

**case**

Outer covering that encloses and protects the device's mechanism.

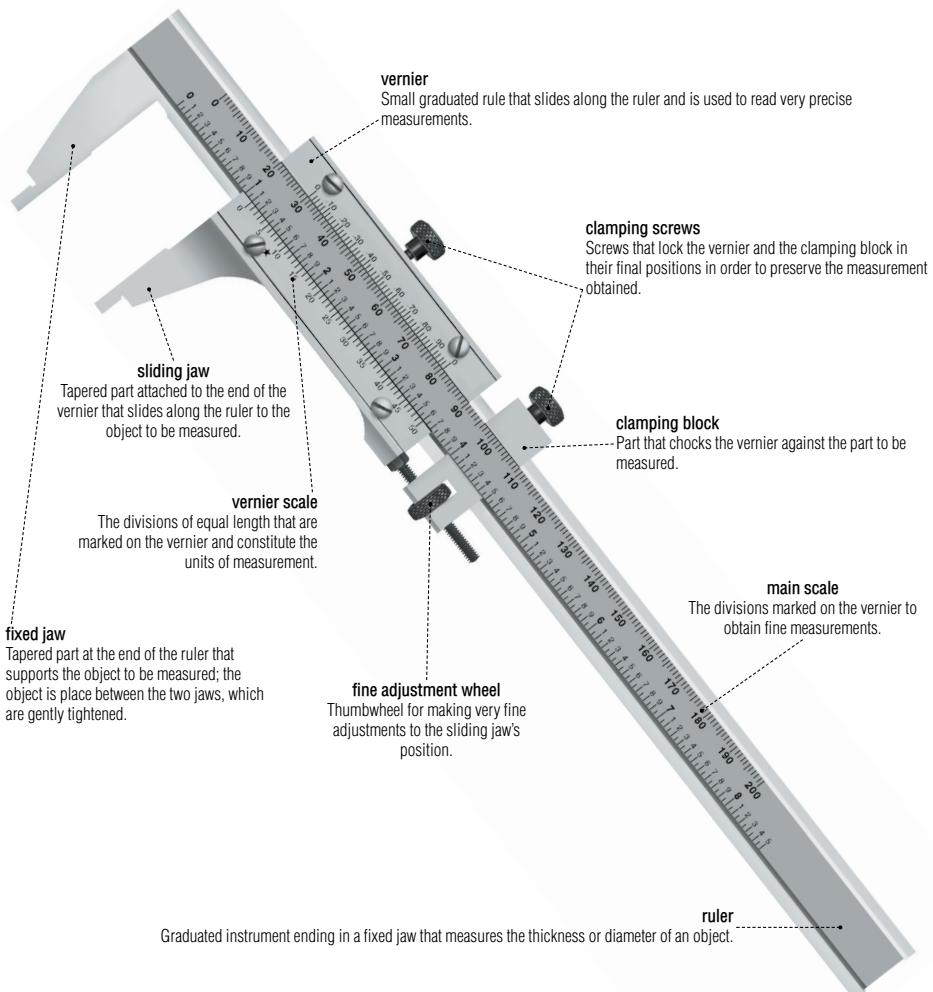
Button for adjusting the average length of a step in the walk or run.

## measure of thickness

Thickness: dimension corresponding to the distance between two surfaces of the same body.

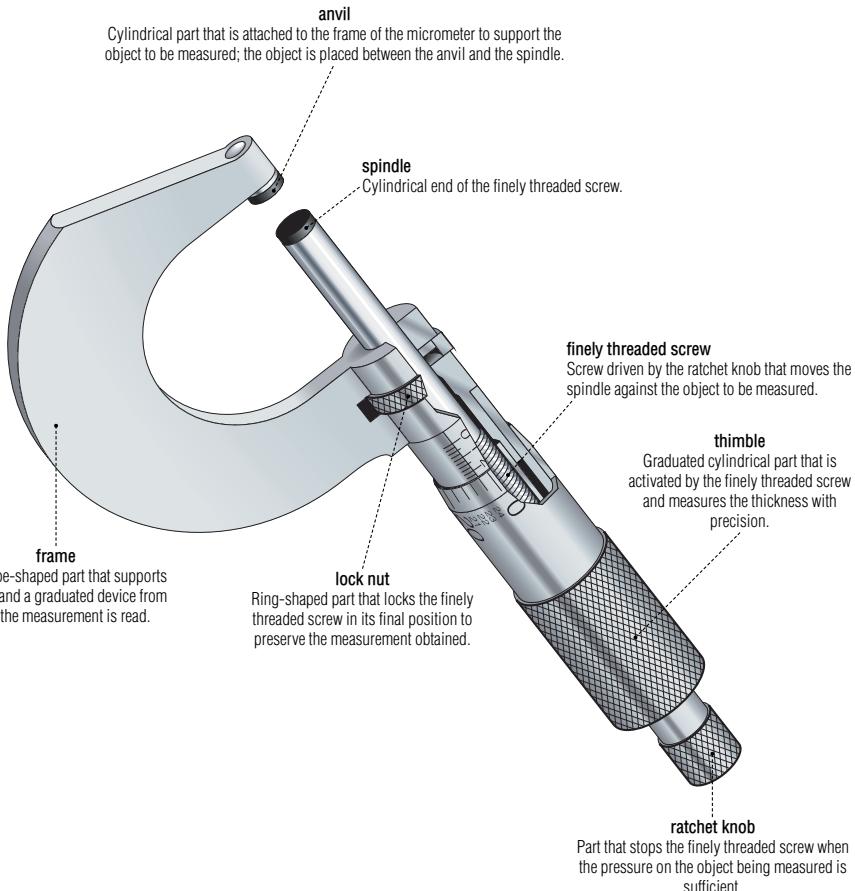
### vernier caliper

Precision instrument for measuring the thickness and diameter of mechanical parts.



**micrometer caliper**

Instrument that measures the thickness or the diameter of relatively small parts; it produces finer results than a vernier caliper.



## measure of angles

Angle: figure formed by two intersecting lines or planes; it is measured in degrees.

### theodolite

Sighting instrument that is used especially in astronomy, geodesy and navigation for measuring horizontal and vertical angles.

### optical sight

Device with an eyepiece that precisely aims the telescope at the target whose angles are to be measured.

### alidade

Part of the theodolite that rotates on a vertical axle to measure angles by means of the telescope.

### adjustment for vertical-circle image

Knob that adjusts the sharpness of the image of the vertical circle (graduated from 0° to 360°) in order to read the angles on the vertical axis.

### micrometer screw

Knob that adjusts the micrometer to give a very precise reading of the circles' measurements.

### adjustment for horizontal-circle image

Knob that adjusts the sharpness of the image of the horizontal circle (graduated from 0° to 360°) in order to read the angles on the horizontal axis.

### horizontal clamp

Knob that locks the alidade to prevent it from rotating.

### leveling head level

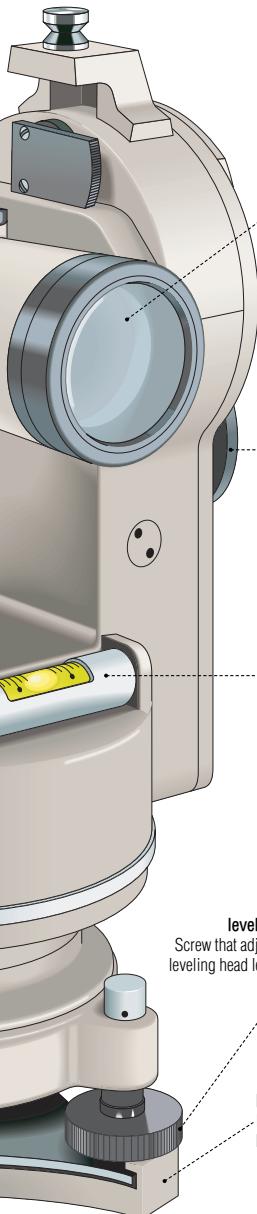
Transparent tube that contains liquid and an air bubble; it serves as a guide for positioning the leveling head on the horizontal axis.

### leveling head

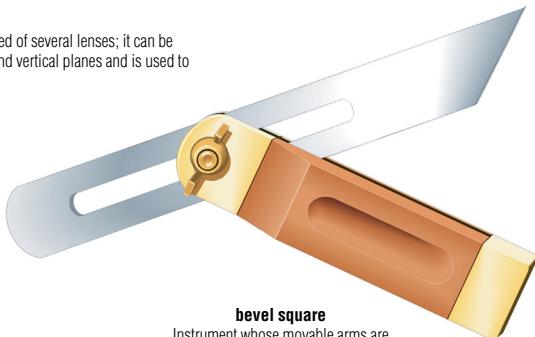
Platform serving as a support for the theodolite.

### leveling head locking knob

Knob that locks the alidade to the leveling head.

**telescope**

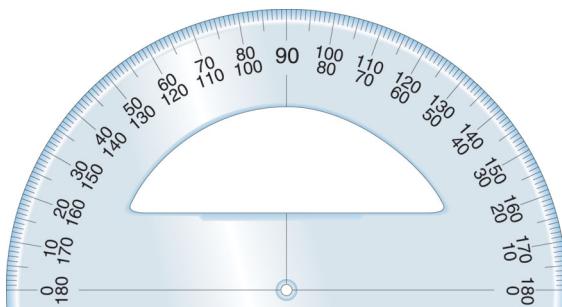
Optical instrument composed of several lenses; it can be adjusted in the horizontal and vertical planes and is used to observe distant objects.

**bevel square**

Instrument whose movable arms are used for measuring or for marking an angle.

**alidade level**

Transparent tube that contains liquid and an air bubble; it serves as a guide for positioning the alidade on the vertical axis.

**protractor**

Graduated semicircular instrument for measuring and drawing angles.

**base plate**

Plate to which the leveling head is attached by means of three leveling screws.

# international system of units

Decimal system established by the 11th General Conference on Weights and Measures (GCWM) in 1960 and used by many countries.

## measurement of electric potential difference



volt

### measurement of frequency



hertz

Frequency of a periodic phenomenon whose period is 1 second.

### measurement of electric charge



coulomb

Amount of electricity carried in 1 second by a current of 1 ampere.

### measurement of energy



joule

Amount of energy released by the force of 1 newton acting through a distance of 1 meter.

### measurement of power



watt

Energy transfer of 1 joule during 1 second.

### measurement of force



newton

Force required to impart an acceleration of  $1 \text{ m/s}^2$  to a body having a mass of 1 kg.

## measurement of electric resistance



ohm

Electrical resistance between two points of a conductor carrying a current of 1 ampere when the difference in potential between them is 1 volt.

## measurement of electric current



ampere

Constant current of 1 joule per second in a conductor.

**measurement of length****m****meter**

Distance traveled by light in a vacuum in  $1/299,792,458$  of a second.

**measurement of mass****kg****kilogram**

Mass of a platinum prototype that was accepted as the international reference in 1889; it is stored at the International Bureau of Weights and Measures.

**measurement of Celsius temperature****°C****degree Celsius**

Division into 100 parts of the difference between the freezing point of water ( $0^{\circ}\text{C}$ ) and its boiling point ( $100^{\circ}\text{C}$ ) at standard atmospheric pressure.

**measurement of thermodynamic temperature****K****kelvin**

Zero degrees Kelvin is equal to minus  $273.16^{\circ}\text{C}$ .

**measurement of pressure****Pa****pascal**

Uniform pressure exerted on a flat surface of  $1\text{ m}^2$  with a force of 1 newton.

**measurement of amount of substance****mol****mole**

Quantity of matter equal to the number of atoms in 0.012 kg of carbon 12.

**measurement of radioactivity****Bq****becquerel**

Radioactivity of a substance in which one atom disintegrates per second.

**measurement of luminous intensity****cd****candela**

Unit of light intensity equivalent to a radiant intensity of  $1/683$  watts per steradian (solid angle).

# mathematics

The science that uses deductive reasoning to study the properties of abstract entities such as numbers, space and functions and the relations between them.

**minus/negative**

Sign denoting that a number is to be subtracted from another; the result is a difference.

**plus/positive**

Sign denoting that a number is to be added to another; the result is a sum.

**multiplied by**

Sign denoting that a number is to be multiplied by another; the result is a product.

**divided by**

Sign denoting that a number (dividend) is to be divided by another (divisor); the result is a quotient.

**equals**

Sign denoting the result of an operation.

**is not equal to**

Sign denoting that the result of an operation is not close to the same value as the one on the right.

**is approximately equal to**

Sign denoting that the result of an operation is close to the same value as the one on the right.

**is equivalent to**

Sign denoting that the value on the left is the same magnitude as the one on the right.

**is identical with**

Binary sign denoting that the result of the operation noted on the left has the same value as the operation noted on the right.

**is not identical with**

Binary sign denoting that the result of the operation noted on the left does not have the same value as the operation noted on the right.

**empty set**

Sign denoting that a set contains no elements.

**union of two sets**

Binary sign denoting that a set is composed of the sum of the elements of two sets.

**intersection of two sets**

Binary sign denoting that two sets M and N have elements in common.

**is included in/is a subset of**

Binary sign denoting that a set A on the left is part of the set B on the right.

**plus or minus**

Sign denoting that the number that follows denotes an order of magnitude.

**is less than or equal to**

Sign denoting that the result of an operation is equal to or of smaller magnitude than the number that follows.

**is greater than**

Sign denoting that the value on the left is of greater magnitude than the number that follows.

**is greater than or equal to**

Sign denoting that the result of an operation is equal to or of greater magnitude than the number that follows.

**is less than**

Sign denoting that the value on the left is of smaller magnitude than the number that follows.

**percent**

Sign denoting that the number preceding it is a fraction of 100.

**is an element of**

Binary sign denoting that the element on the left is included in the set on the right.

**is not an element of**

Binary sign denoting that the element on the left is not included in the set on the right.

**sum**

Sign indicating that several values are to be added together (their sum).

**square root of**

Sign denoting that, when a number is multiplied by itself, the result is the number that appears below the bar.

**fraction**

Sign denoting that the number on the left of the slash (numerator) is one part of the number on the right of the slash (denominator).

**infinity**

Symbol denoting that a value has no upper limit.

**integral**

Result of the integral calculation used especially to determine an area and to resolve a differential equation.

**factorial**

Product of all positive whole numbers less than and equal to a given number. For example, the factorial of 4 is:  $4! = 1 \times 2 \times 3 \times 4 = 24$ .

## mathematics

**Roman numerals**

Uppercase letters that represented numbers in ancient Rome; they are still seen today in uses such as clock and watch dials and pagination.



one

Letter whose value is 1 unit.



five

Letter whose value is 5 units.



ten

Letter whose value is 10 units.



fifty

Letter whose value is 50 units.



one hundred

Letter whose value is 100 units.



five hundred

Letter whose value is 500 units.



one thousand

Letter whose value is 1,000 units.

## biology

The scientific study of living organisms (humans, animals and plants) from the point of view of their structure and how they function and reproduce.



male

Symbol denoting that a being has male reproductive organs.



female

Symbol denoting that a being has female reproductive organs.



blood factor positive

Individuals are Rh positive when their red blood cells carry an Rh molecule (antigen); the Rh factor is positive in about 85% of the population.



blood factor negative

Individuals not carrying the Rh molecule (antigen) are Rh negative; the Rh factor plays an important role in pregnancy (the parents' factors must be compatible).



death

Symbol placed before a date denoting a person's year of death.



birth

Symbol placed before a date denoting a person's year of birth.

Mathematical discipline that studies the relations between points, straight lines, curves, surfaces and volumes.

**degree**

Symbol placed in superscript after a number to denote the opening of an angle or the length of an arc, or in front of an uppercase letter to identify a scale of measurement.

**minute**

Symbol placed in superscript after a number that denotes degrees in sixtieths of a measure.

**second**

Symbol placed in superscript after a number that denotes degrees in sixtieths of a minute.

**pi**

Constant that represents the ratio of a circle's circumference to its diameter; its value is approximately 3.1416.

**perpendicular**

Symbol denoting that a straight line meets another at a right angle.

**is parallel to**

Symbol denoting that two straight lines remain at a constant distance from one another.

**is not parallel to**

Symbol denoting that two straight lines do not remain at a constant distance from one other.

**right angle**

Angle formed by two lines or two perpendicular planes that measures 90°.

**obtuse angle**

Angle between 90° and 180°.

**acute angle**

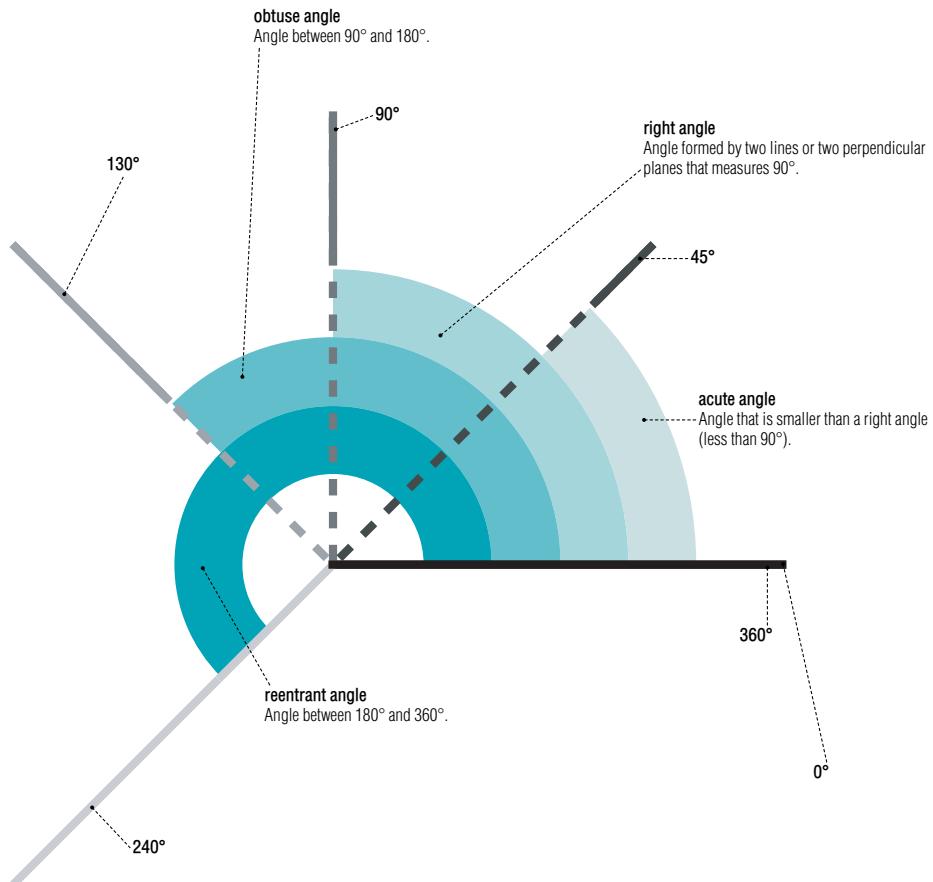
Angle that is smaller than a right angle (less than 90°).

# geometrical shapes

Drawings that represent various geometric forms such as straight lines, circles and polygons.

## examples of angles

Angle: figure formed by two intersecting lines or planes; it is measured in degrees.



**plane surfaces**

Set of points on a plane that describes an area of space.

**parts of a circle**

Circle: closed plane curve; all its points are the same distance from a fixed point (center).

**center**  
Point located at the same distance from every point on the circle's circumference.

**quadrant**  
Quarter of a circle's circumference; it corresponds to an arc of  $90^\circ$ .

**diameter**  
Line that connects two points on a circle's circumference and passes through its center.

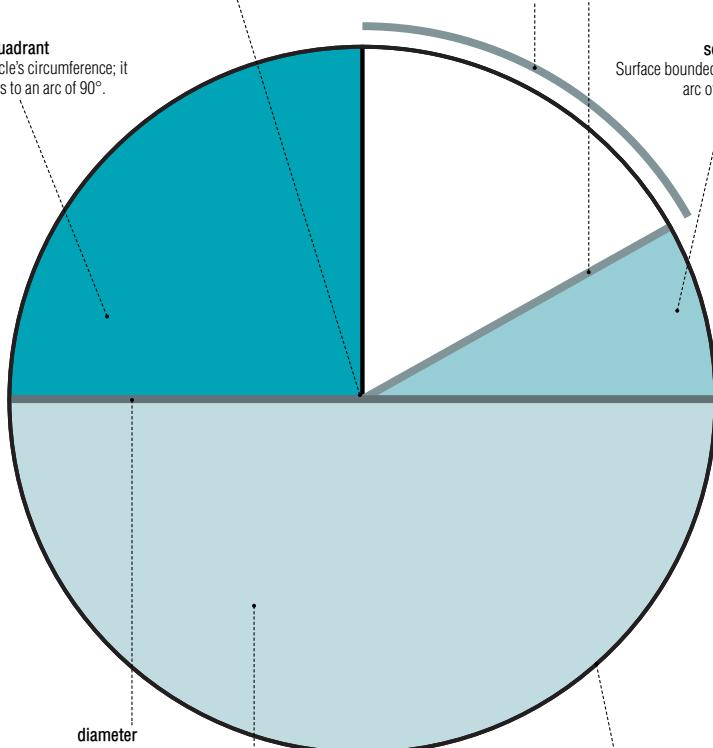
**arc**  
Section of a circle between two points on the circle.

**semicircle**  
A half circle that is delimited by its diameter.

**radius**  
Line that joins a point on a circle's circumference to its center; it is one half of the diameter.

**sector**  
Surface bounded by two radii and an arc of a circle.

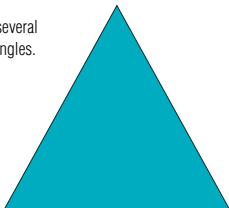
**circumference**  
Length of a circle that corresponds to the product of its diameter and pi.



## geometrical shapes

**polygons**

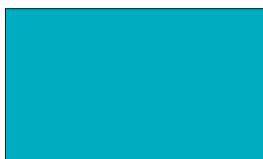
Geometric plane figures with several sides and a number of equal angles.

**triangle**

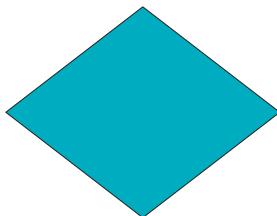
Three-sided polygon; triangles are scalene (no side is equal to any other) isosceles (two sides equal) or equilateral (all sides equal).

**square**

Equilateral rectangle with four right angles.

**rectangle**

Quadrilateral whose opposite sides are equal in length; the sides meet at right angles.

**rhombus**

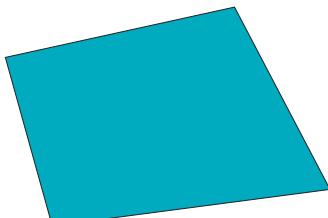
Equilateral parallelogram.

**trapezoid**

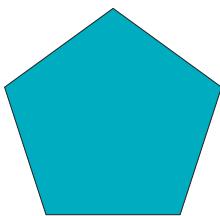
Quadrilateral with two sides (bases) that are parallel. It is isosceles when it has two sides that are not parallel and equal, and rectangle when two of its sides form a right angle.

**parallelogram**

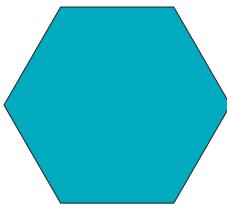
Trapezoid whose opposite sides are parallel and of equal length; the sides do not meet at right angles.

**quadrilateral**

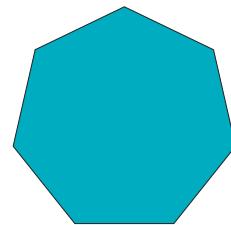
Any plane figure with four sides and four angles.

**regular pentagon**

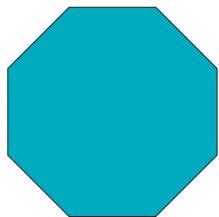
Polygon with five (penta = five) sides and equal angles.

**regular hexagon**

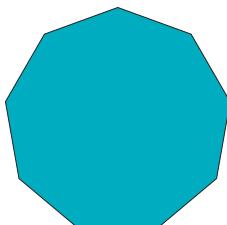
Polygon with six (hexa = six) sides and equal angles.

**regular heptagon**

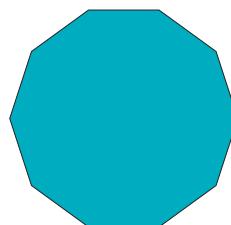
Polygon with seven (hepta = seven) sides and equal angles.

**regular octagon**

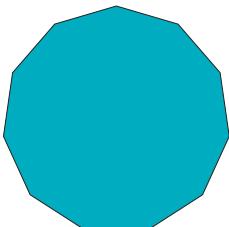
Polygon with eight (octo = eight) sides and equal angles.

**regular nonagon**

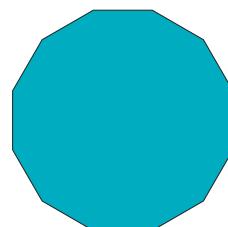
Polygon with nine (nona = nine) sides and equal angles.

**regular decagon**

Polygon with 10 (deca = ten) sides and equal angles.

**regular hendecagon**

Polygon with 11 (hendeca = eleven) sides and equal angles.

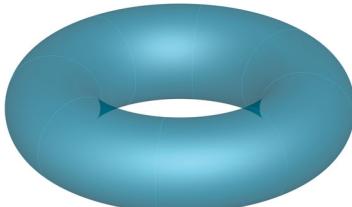
**regular dodecagon**

Polygon with 12 (dodeca = twelve) sides and equal angles.

## geometrical shapes

**solids**

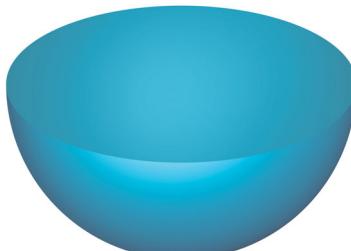
Geometric shapes in three dimensions that are delimited by surfaces.

**torus**

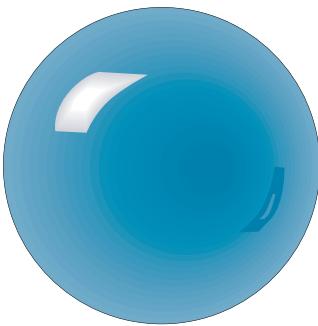
Volume or solid generated by the rotation of a circle at an equal distance from its center of rotation.

**helix**

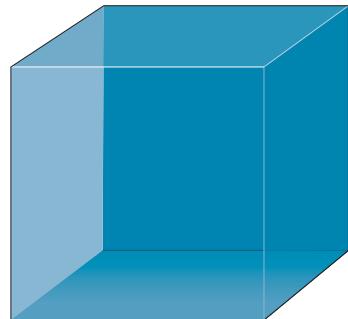
Volume or solid of spiral shape that turns toward the left at a constant angle.

**hemisphere**

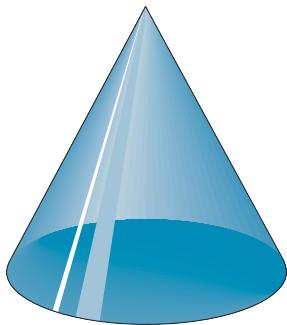
Half sphere cut along its diameter.

**sphere**

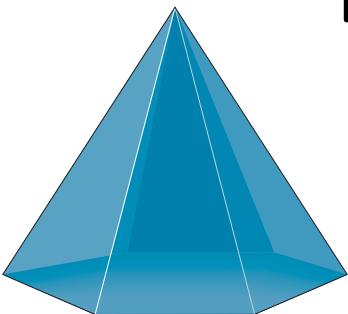
Volume with all the points on its surface the same distance from its center; the solid thus delimited is a round ball.

**cube**

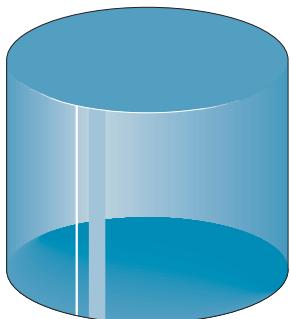
Volume or solid with six square sides of equal area and six equal edges; it has eight vertices.

**cone**

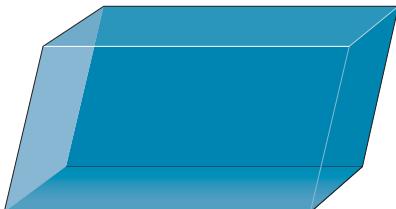
Volume or solid generated by the rotation of a straight line (generatrix) along a circular line (directrix) from a fixed point (vertex).

**pyramid**

Volume or solid generated by straight lines (edges) connecting the angles of a polygon (base) to the vertex and whose sides form triangles.

**cylinder**

Volume or solid generated by the rotation of a straight line (generatrix) moving along a curved line (directrix).

**parallelepiped**

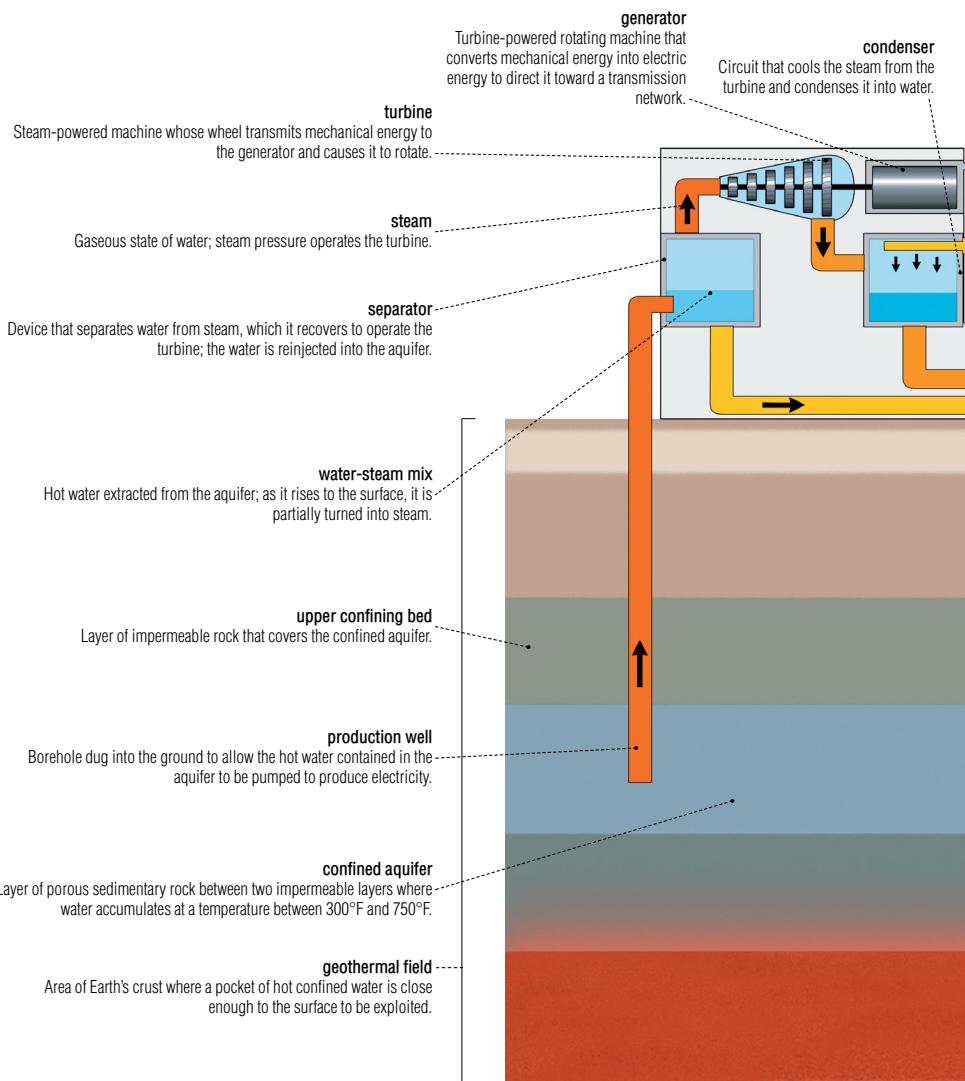
Volume or solid with six sides (parallelograms) that are parallel in pairs.

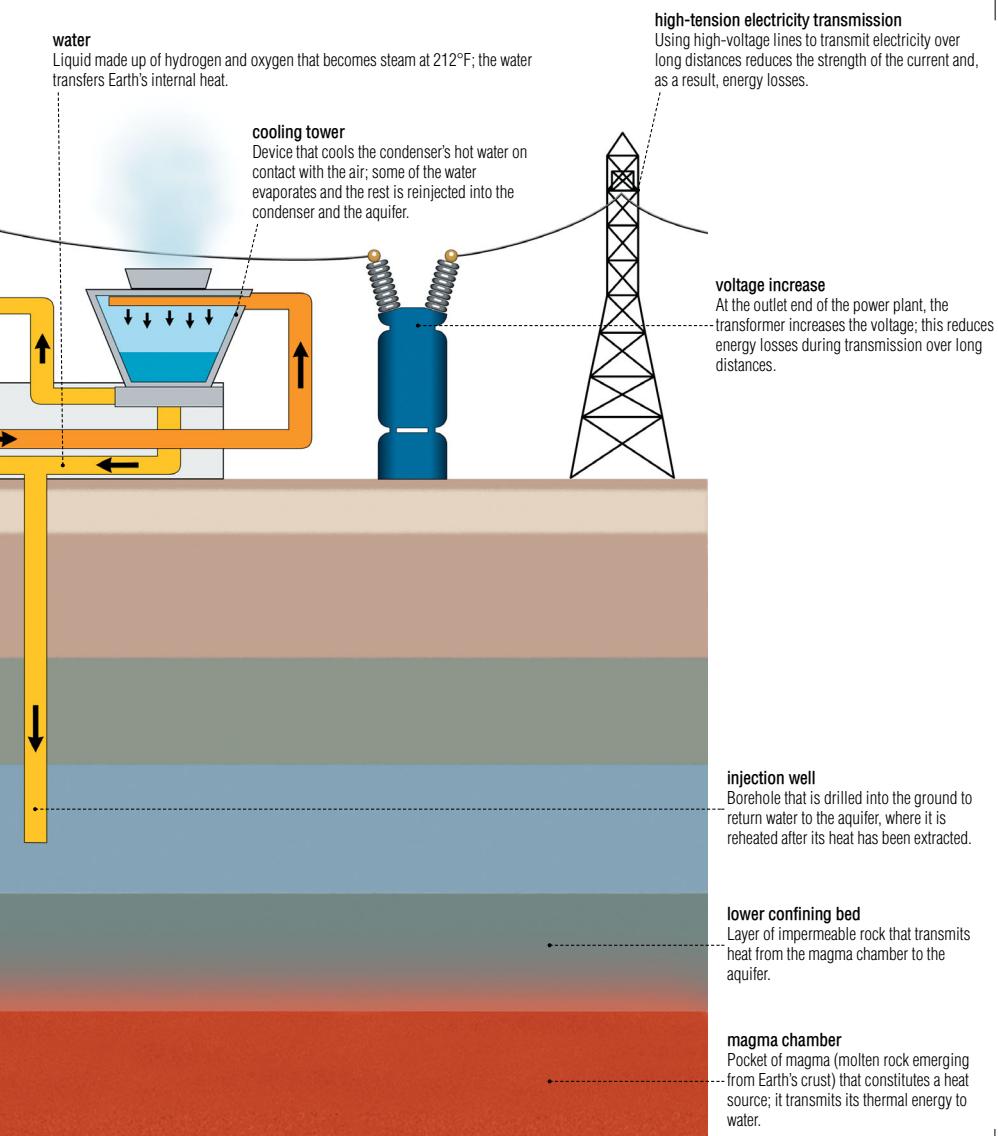
**regular octahedron**

Volume or solid with eight triangular sides of equal area; it has six vertices and 12 edges.

## production of electricity from geothermal energy

Hot water contained in the ground near a volcano, geyser or thermal source is piped to the surface by drilling to extract steam and produce electricity.



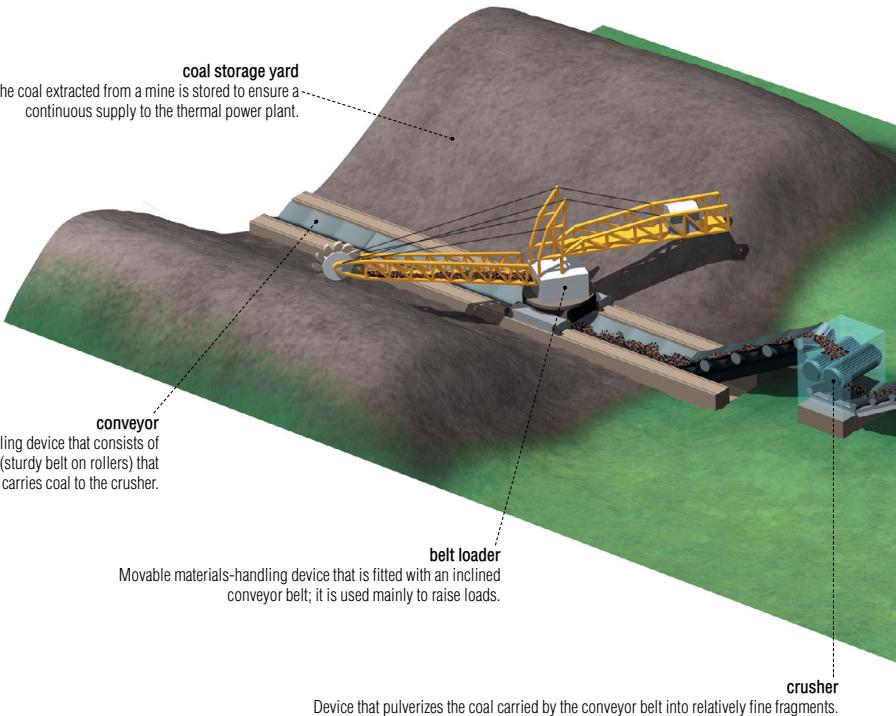


## thermal energy

Energy that is produced by turning water into steam through the burning of fuel (e.g., petroleum and coal) or through nuclear reaction.

### production of electricity from thermal energy

The heat that is given off by burning combustible fuels in the thermal power plant converts water into steam; the steam turns a turbo-alternator unit to produce electricity.



**pulverizer**

Device that pulverizes coal into a very fine powder so that it burns more easily in the steam generator.

**steam generator**

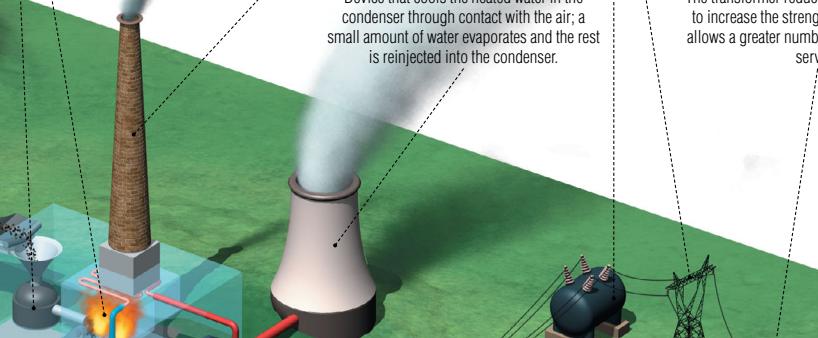
Device that uses the heat produced from burning coal to convert water into steam; the steam powers the turbo-alternator unit.

**stack**

Pipe through which gases produced by burning coal are discharged; these gases are first partially cleaned to reduce pollution.

**cooling tower**

Device that cools the heated water in the condenser through contact with the air; a small amount of water evaporates and the rest is reinjected into the condenser.

**coal-fired thermal power plant**

Plant that produces electricity from thermal energy by burning coal.

**condenser**

Circuit that cools the steam from the turbine and condenses it into water, which is reintroduced into the steam generator.

**voltage increase**

At the outlet end of the power plant, the transformer increases the voltage; this reduces energy losses during transmission over long distances.

**high-tension electricity transmission**

Using high-voltage lines to transmit electricity over long distances reduces the strength of the current and, as a result, energy losses.

**voltage decrease**

The transformer reduces the voltage in order to increase the strength of the current; this allows a greater number of consumers to be served.

**transmission to consumers**

Electricity is carried to areas of consumption over low-voltage distribution lines.

**turbo-alternator unit**

Device with a turbine that transmits the water's mechanical energy to the alternator's rotor to make it turn to produce electricity.

## coal mine

The underground or open-pit facilities that are set up around a coal deposit in order to extract it.

### open-pit mine

Type of mining that is used for shallow deposits; coal or ore is extracted by digging a succession of benches from the surface of the ground downward.

### bench

The levels of a quarry that are arranged like steps of a staircase and from which coal or ore is extracted.

### face

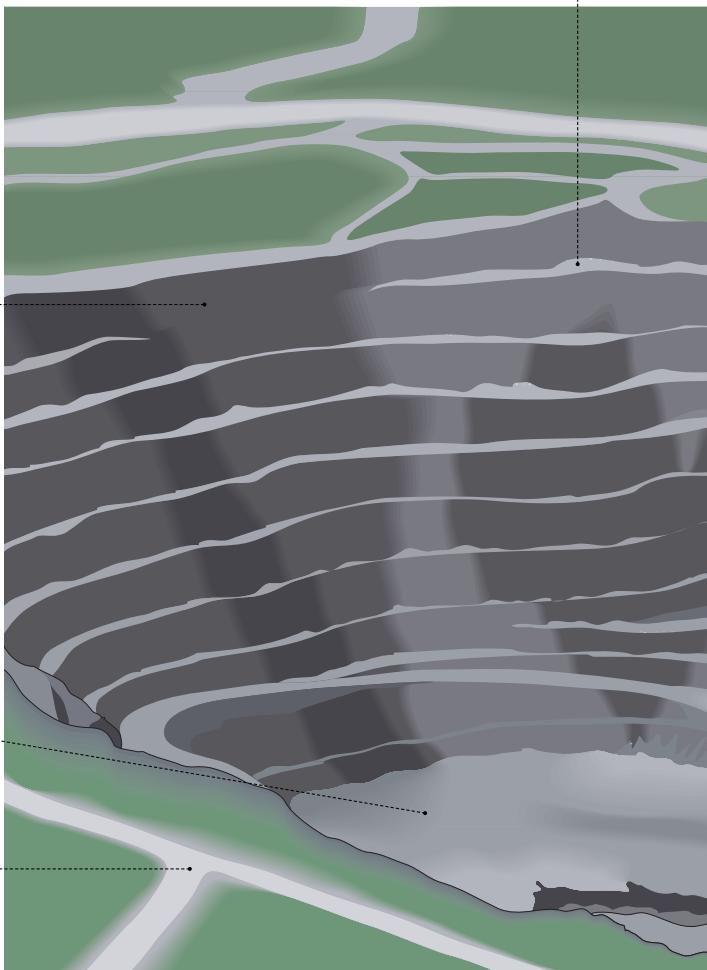
Vertical surface created by dynamiting a deposit to extract its ore.

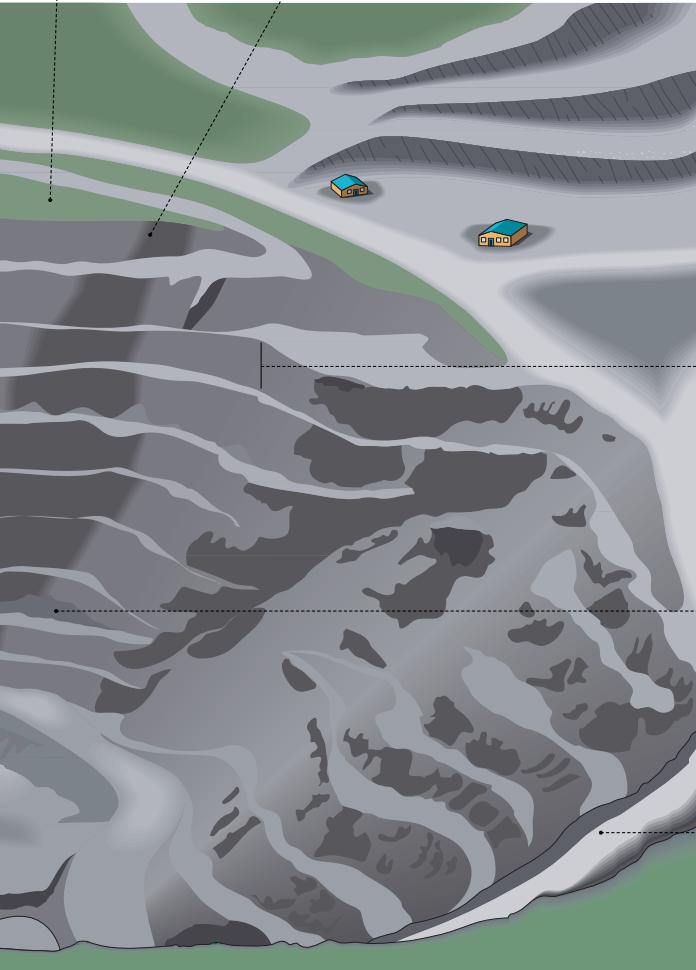
### crater

Depression that forms the bottom of the quarry; it is a result of the extraction of deposits.

### haulage road

Access road leading to the quarry; it is used to haul coal to the treatment plant.



**ground surface**

The land that covers the deposit.

**overburden**

Part of the ground that covers the ore beds; it is removed to reach the deposit.

**bench height**

Vertical distance between the horizontal planes of two benches.

**ore**

Solid fossil fuel that is black and contains a large amount of carbon.

**ramp**

Roadway between two benches; it is inclined so that motorized vehicles can remove the ore extracted from the various levels.

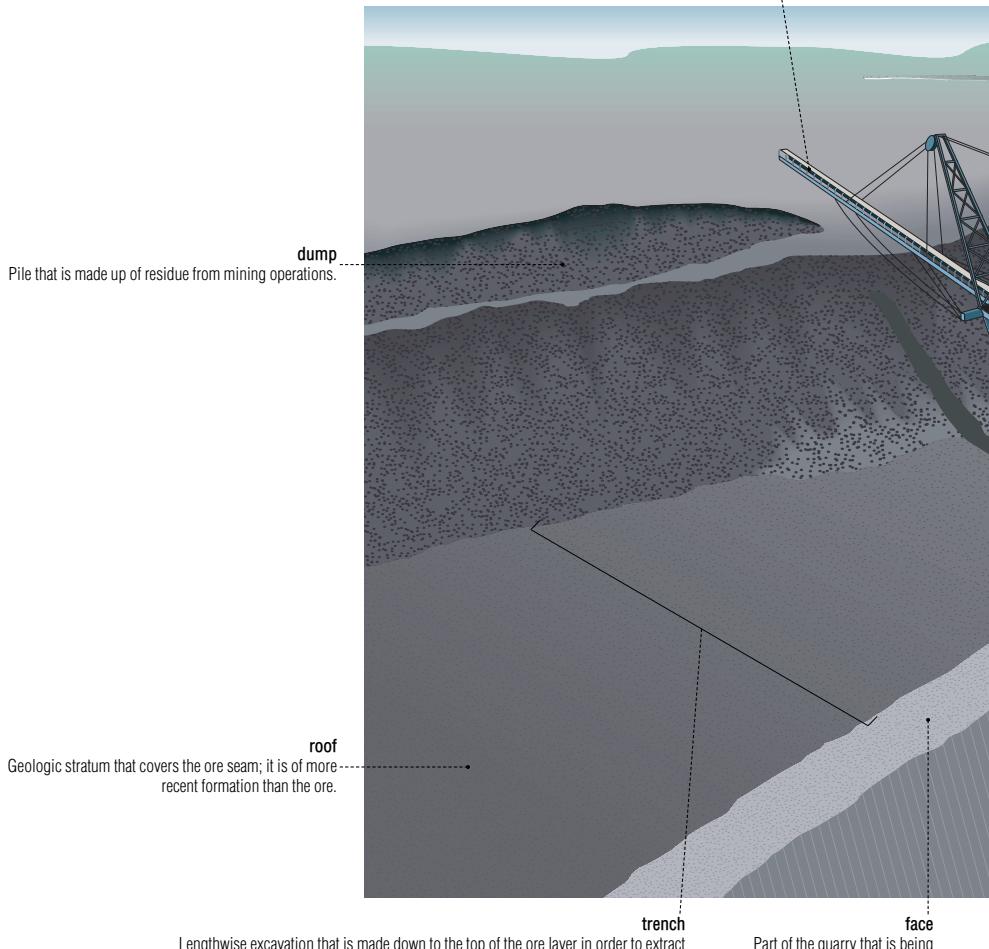
## coal mine

**strip mine**

Type of mining that is used especially for large shallow deposits; coal or ore is extracted by digging a trench in the ground surface.

**conveyor**

Materials-handling device that consists of a conveyor belt (sturdy belt on rollers) that is used to transport coal extracted from the mine.

**roof**

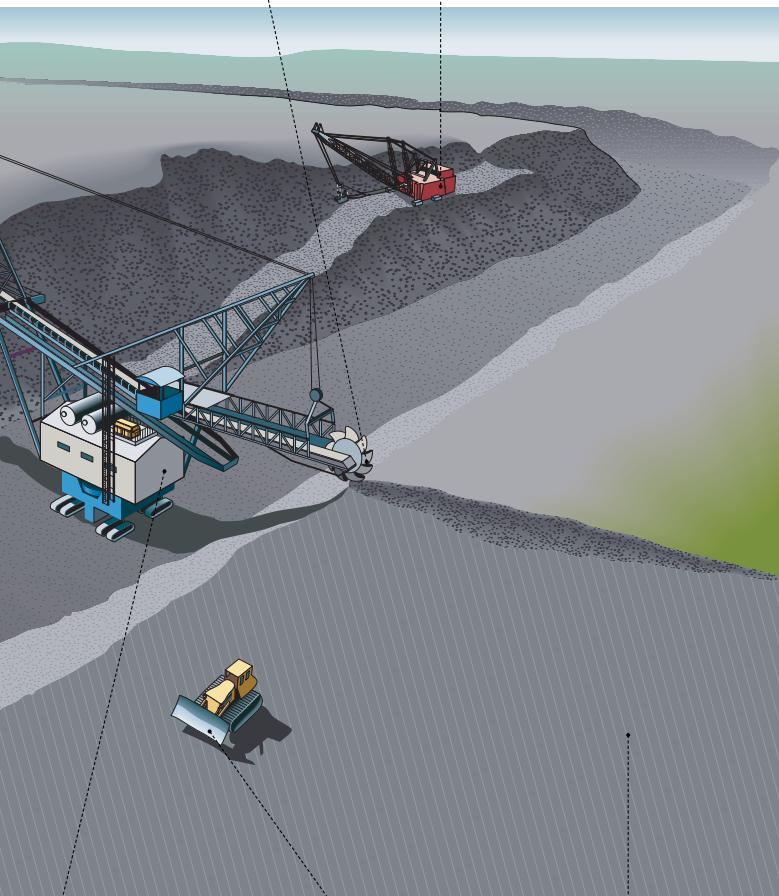
Geologic stratum that covers the ore seam; it is of more recent formation than the ore.

**trench**

Lengthwise excavation that is made down to the top of the ore layer in order to extract its coal.

**face**

Part of the quarry that is being excavated and from which ore is progressively extracted.

**bucket wheel excavator**

Earthmover that consists of a wheel fitted with buckets (scoops); it is used to dig into rock to extract materials, which are then dumped onto a conveyor.

**mechanical shovel**

Earthmover that consists of a movable cab with an articulated arm fitted with a bucket (scoop); it is used for digging and handling loads.

**belt loader**

Movable materials-handling device that is fitted with an inclined conveyor belt; it is used mainly to raise loads.

**bulldozer**

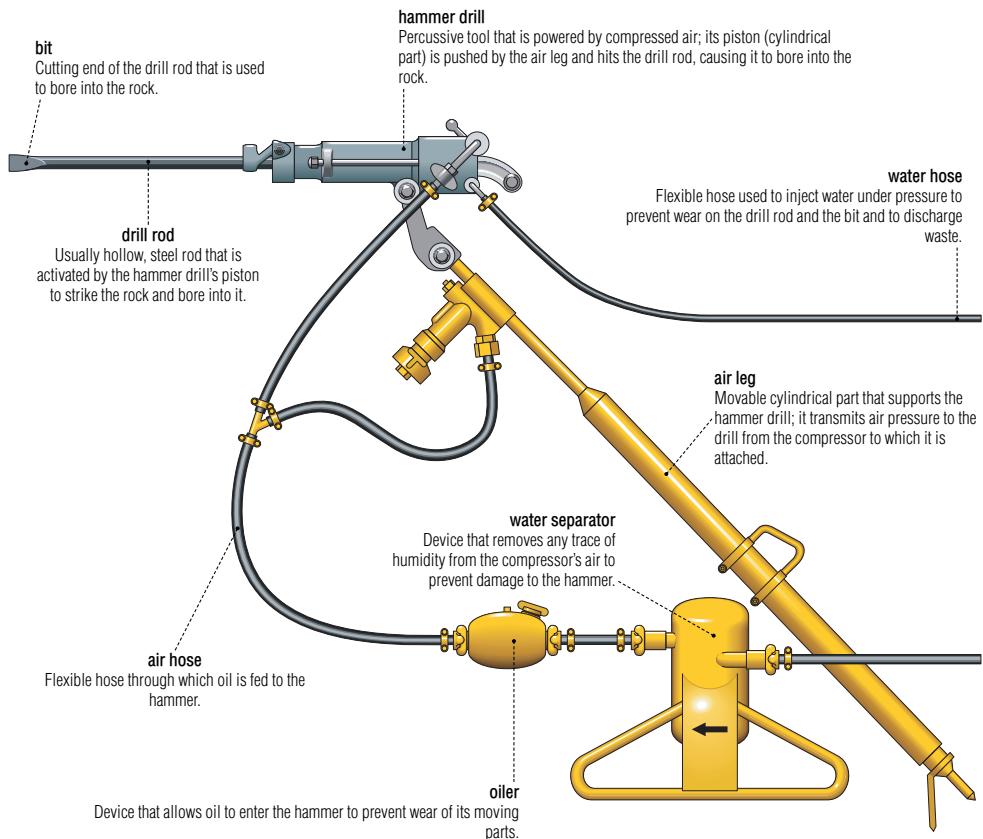
Excavation machine for pushing materials; it is made up of a crawler tractor, a blade and often a ripper.

**overburden**

Part of the ground that covers the ore beds; it is removed to reach the deposit.

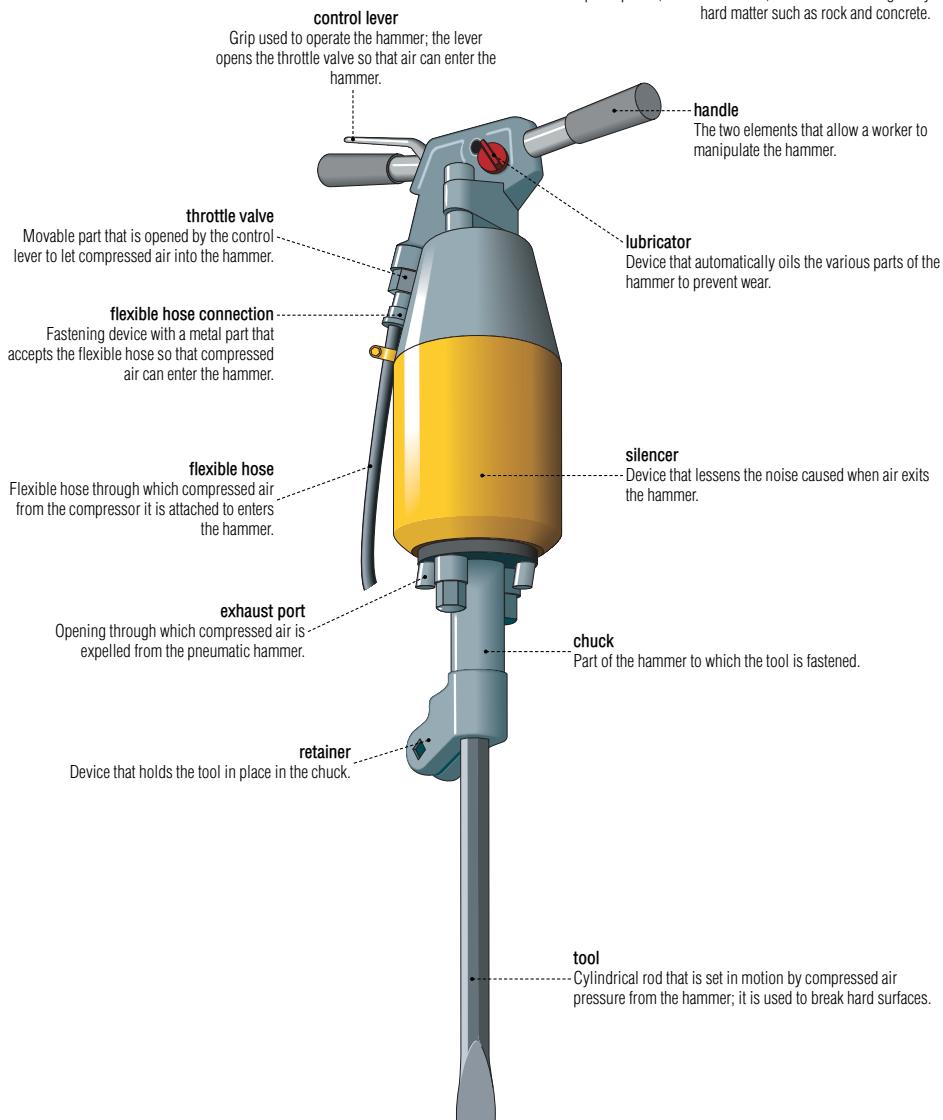
**jackleg drill**

Percussive tool that is powered by compressed air; it is used to bore holes into hard rock. The air leg makes the job easier for the drill operator.



**pneumatic hammer**

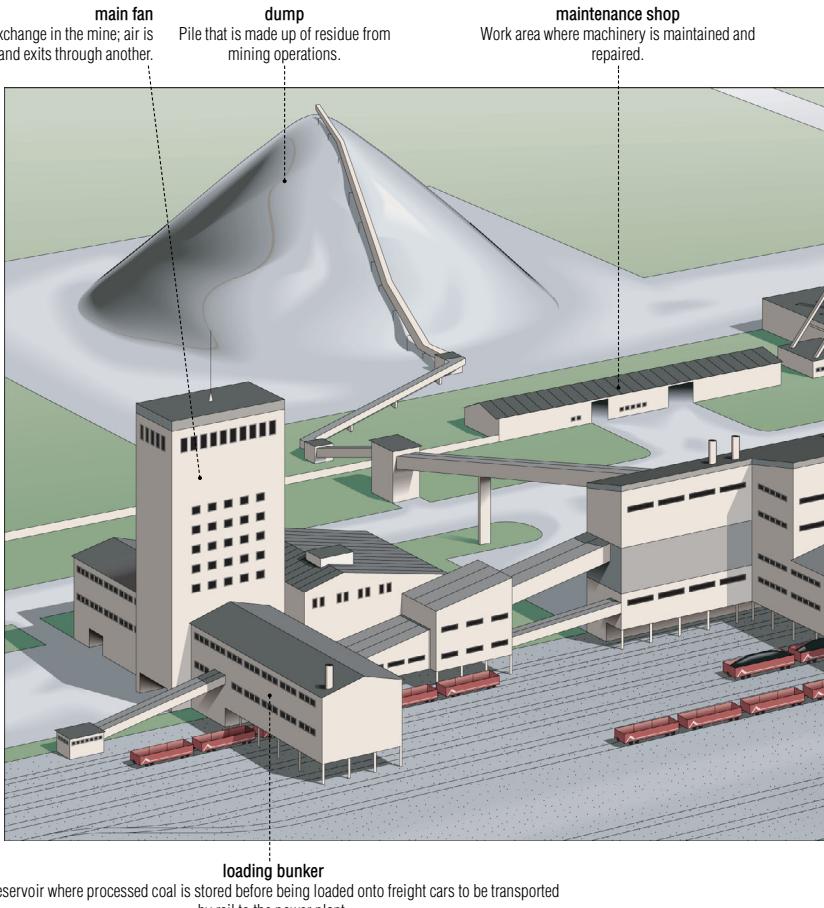
Percussive tool that is powered by compressed air; with the help of a piston, it activates a tool, which breaks through very hard matter such as rock and concrete.

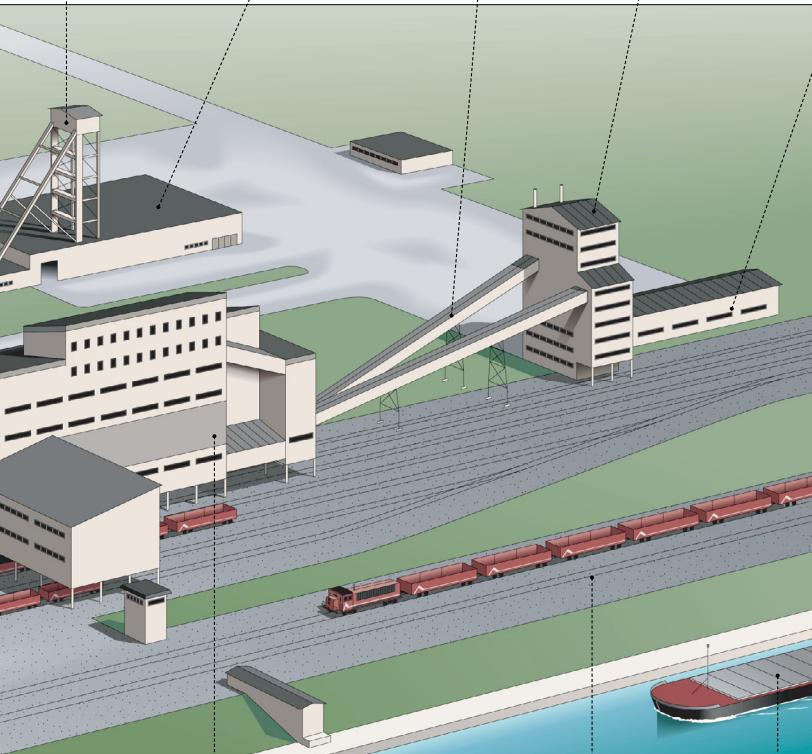


## coal mine

### pithead

The surface facilities needed for underground mining (including extraction machinery, storage areas and offices).



**headframe**

Opening at the top of the shaft that connects the aboveground facilities (including ventilation fans and hoists) to the underground areas being mined.

**miners' changing-room**

Area with sanitary facilities (showers, toilets) where miners can go mainly to change their clothes.

**conveyor**

Materials-handling device that consists of a conveyor belt (sturdy belt on rollers); it is used to carry coal to the treatment plant.

**winding tower**

Building that houses the shaft's hoisting equipment (including motors and hoisting cables); it provides communication between the surface and the mine galleries.

**hoist room**

Area that houses the hoist (cylinder) on which the hoisting cables are wound; it controls movement of the elevators and skip hoists in the shaft.

**treatment plant**

Place where all processing activities (including crushing and washing) are carried out to prepare the coal for market.

**rail track**

The tracks formed of two parallel rails on which trains travel to transport coal.

**maritime transport**

Means of transport that uses barges to transport coal over water.

## coal mine

**underground mine**

Property in which excavations are carried out to extract deeply embedded (between 30 and 11,500 ft) coal for industrial mining.

**headframe**

Opening at the top of the shaft that connects the aboveground facilities (including ventilation fans and hoists) to the underground areas being mined.

**vertical shaft**

Shaft that is dug perpendicular to the surface; it serves various levels and is used mainly to transport personnel, equipment and ore.

**elevator**

Power lift fitted with a cab that transports coal or miners between the various levels.

**pillar**

Mass of ore that is left unmined at regular intervals in an excavation (chamber); it provides stability for the upper layers.

**room**

Cavity that remains after the ore is extracted; pillars support its roof.

**chute**

Vertical or inclined passageway through which ore, equipment, personnel and air move from one level of the mine to the other.

**cross cut**

Horizontal passageway that cuts through the ore bed perpendicularly; it provides communication between the passageways and helps to ventilate the mine.

**manway**

Passageway allowing workers to move around in the mine.

**drift**

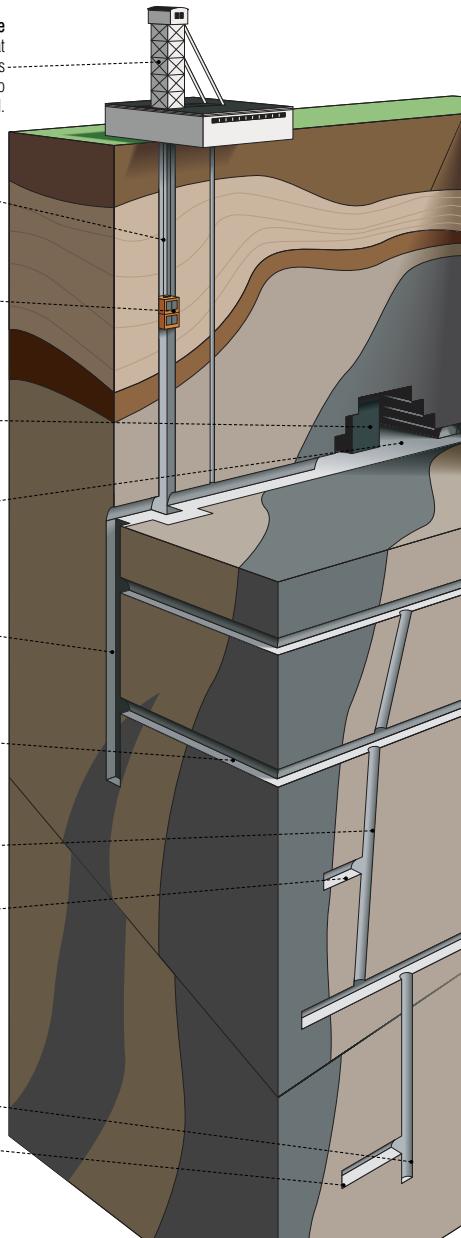
Passageway dug horizontally along the grade line of the ore seam; it can also be dug into the ore vertically.

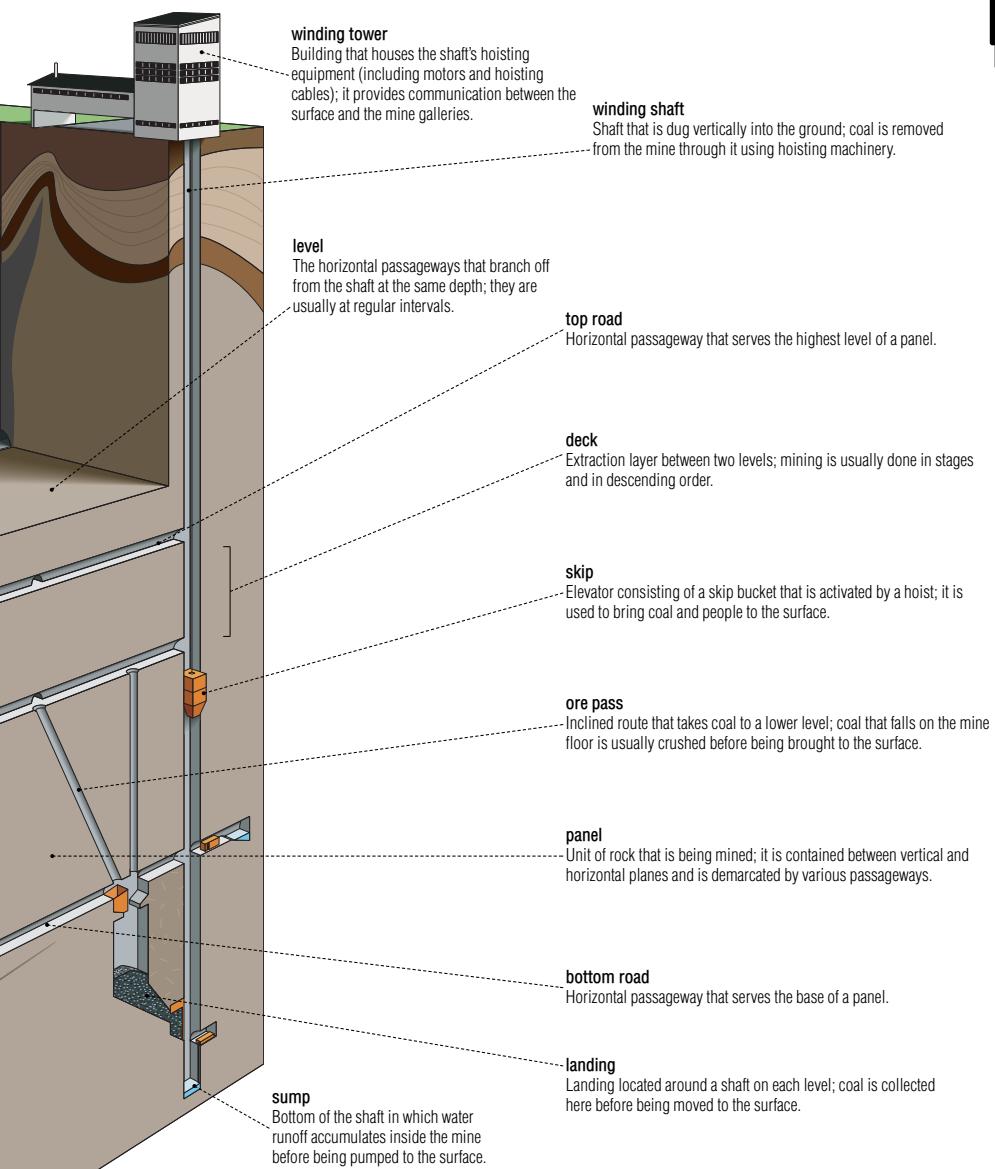
**winze**

Vertical or inclined passageway that connects two levels; it is dug downward from inside the mine and not from the surface.

**face**

Opening that is dug laterally into the rock as coal is extracted.



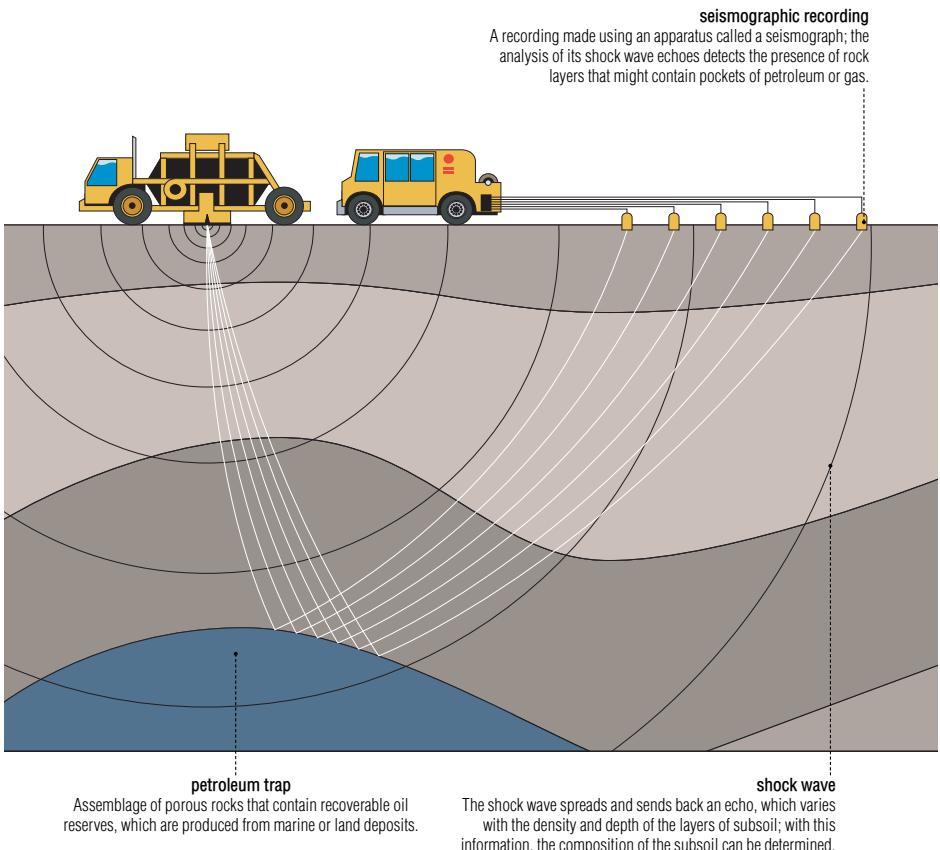


**oil**

Flammable, relatively viscous oily liquid that is used as an energy source; it is made up of various hydrocarbons resulting from the decomposition of plant life over millions of years.

**surface prospecting**

Searching for potential oil deposits by studying the structure of the subsoil using a seismograph.

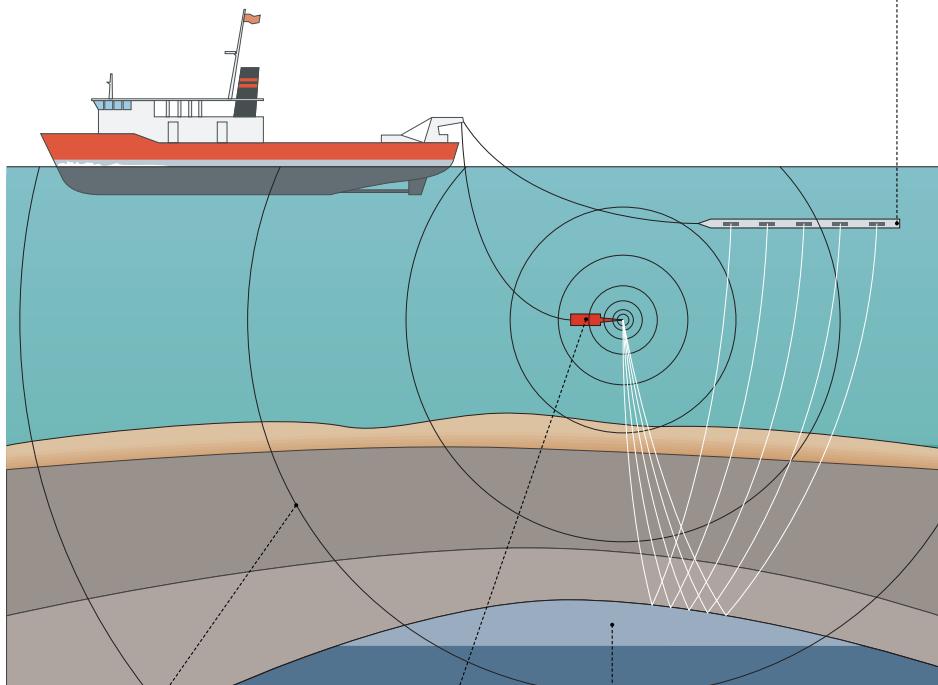


**offshore prospecting**

Vibrations from an exploding charge in the sea are used to locate oil deposits; prospecting offshore is more difficult than on land.

**seismographic recording**

A recording made using an apparatus called a seismograph; the analysis of its shock wave echoes detects the presence of rock layers that might contain pockets of petroleum or gas.

**shock wave**

The shock wave spreads and sends back an echo, which varies with the density and depth of the layers of subsoil; with this information, the composition of the subsoil can be determined.

**blasting charge**

Quantity of explosives (substances capable of discharging high-temperature gases over a very short time period) that produce shock waves when detonated.

**petroleum trap**

Assemblage of porous rocks that contain recoverable oil reserves, which are produced from marine or land deposits.

oil

**drilling rig**

All the drilling machinery and devices that are used to excavate and extract oil from the ground.

Metal structure erected over an oil well; tools for drilling through rock are raised and lowered through it.

**mud injection hose**

Flexible hose that introduces the drilling mud into the swivel.

**swivel**

Piece attached to the lifting hook and the kelly; it is used to introduce mud into the drill pipe to cool and lubricate the bit.

**drilling drawworks**

Device that consists of a cylinder on which hoisting cables are wound; it is used to lower the drill pipes and bit into the well and to lift them out.

**substructure**

Metal infrastructure that supports the derrick, engines and auxiliary equipment.

**vibrating mudscreen**

Perforated vibrating tray that is used to filter mud as it exits the well to remove debris and recycle the mud.

**drill pipe**

Hollow steel rods that are joined together according to the depth of the excavation; their rotation activates the bit.

**drill collar**

Heavy steel tube immediately above the bit that applies a certain weight to the bit to help it cut into the rock.

**bit**

Rotating drill bit with toothed steel or diamond wheels; it bores into rock to break it up and drill a hole.

**oil**

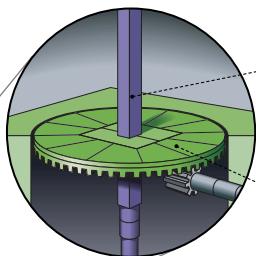
Flammable, relatively viscous oily liquid that is used as an energy source; it is made up of various hydrocarbons resulting from the decomposition of plant life over millions of years.

**gas**

Mixture of gaseous hydrocarbons (mainly methane) that are found in underground deposits, which sometimes also contain crude oil; it is used mainly as a fuel.

**rotary system**

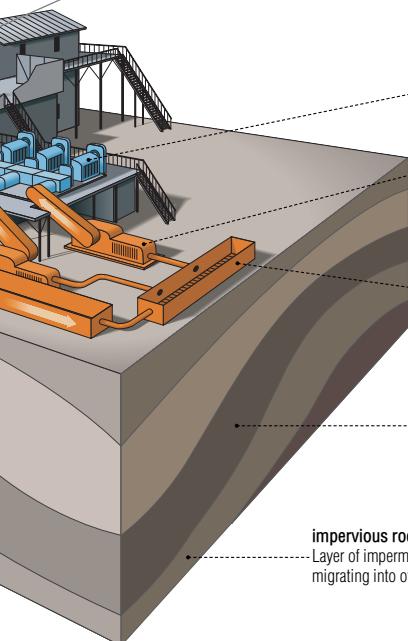
Drilling device in which a kelly is attached to a rotary table; with the help of powerful motors, it transmits the rotative movement to the kellys.

**kelly**

Special square rod that is screwed to the top of the drill pipes and driven by the rotary table.

**rotary table**

Circular table that is moved by powerful motors; it transmits its rotative movement to the drill pipes by means of the kelly.

**engine**

Device converting the combustion of fuel and air into mechanical energy.

**mud pump**

Device that circulates the mud in the drilling rig.

**mud pit**

Basin that contains mud (a mixture of water, clay and chemical products) used mainly to cool and lubricate the bit and to remove debris.

**anticline**

Geologic stratum that results from the convex folding of rock formations; large pools of oil often accumulate in it.

**impervious rock**

Layer of impermeable rock that covers and protects the oil deposit; it prevents hydrocarbons from migrating into other rocks.

oil

**production platform**

Facility used to extract underwater oil deposits; the separation and treatment of hydrocarbons are mainly done here.

**derrick**  
Metal structure erected over an oil well; tools for drilling through rock are raised and lowered through it.

**oil processing area**  
Area where crude oil is pretreated at the head of the well.

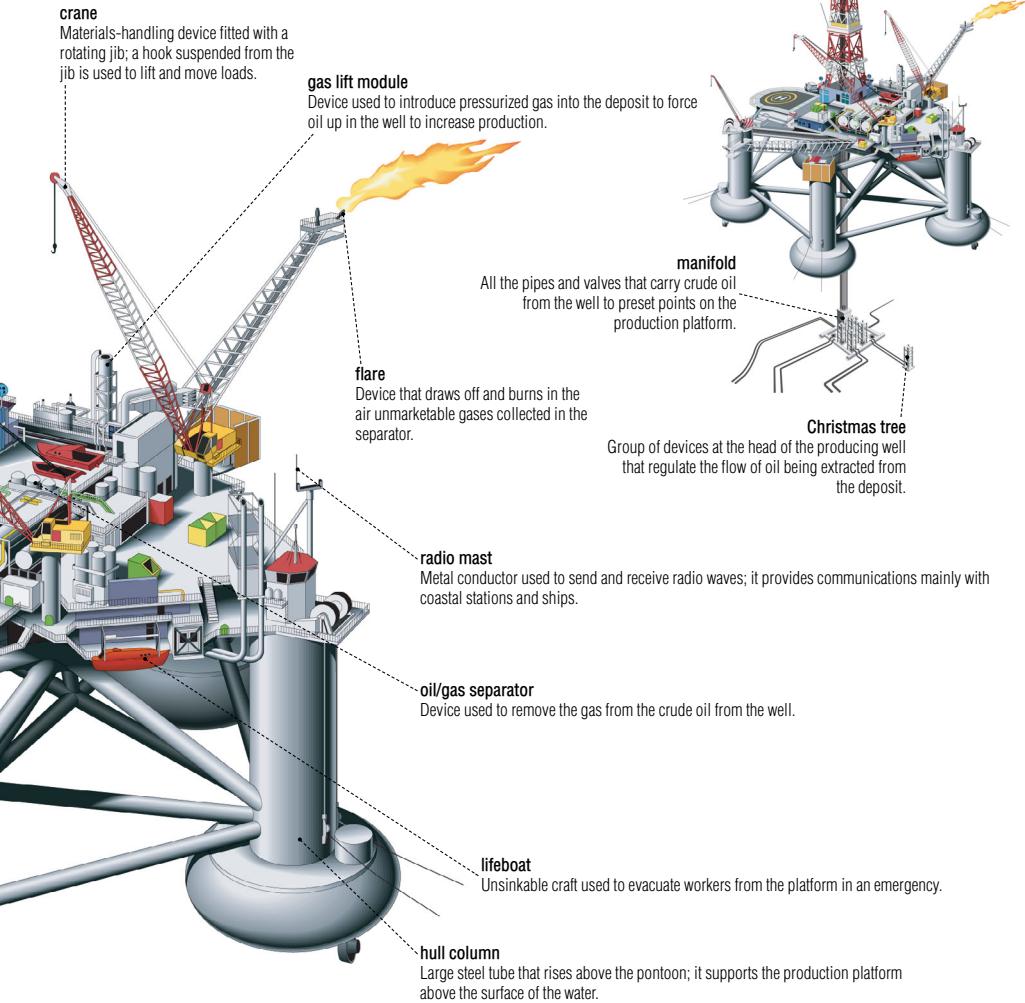
**helipad**  
Site where helicopters land and take off.

**tubular member**  
Steel tube that connects the platform's various hull columns to reinforce the structure.

**anchor wires**  
They anchor the pontoon securely to the ocean floor to ensure the stability of the platform.

**pontoon**  
Submerged floating caisson at the base of the hull column; seawater or oil are stored here to stabilize the platform.

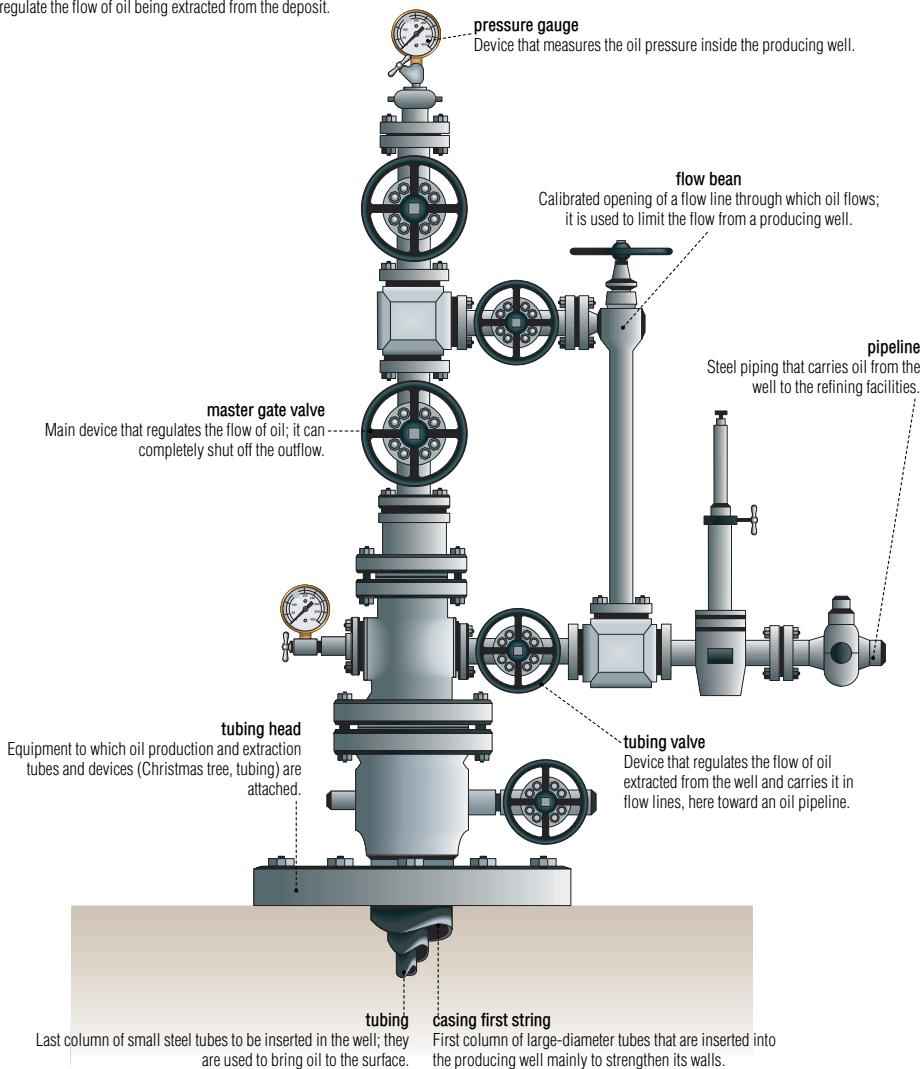
**production/export riser system**  
Vertical steel tubes that link the wellhead and the drilling platform; the system removes mud and oil.



oil

**Christmas tree**

Group of devices at the head of the producing well that regulate the flow of oil being extracted from the deposit.



**refinery products**

Refining of crude oil yields hundreds of useful products.

**petrochemicals**

Chemical products derived from petroleum-based products; they are found in fertilizers, detergents, plastics and other products.

**jet fuel**

Aviation fuel used to power jet engines.

**gasoline**

Motor fuel that is used mainly by the automotive industry to power internal combustion engines.

**kerosene**

Fuel used for lighting and heating.

**stove oil**

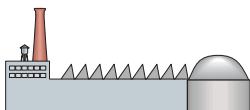
Fuel used mainly in home furnaces.

**diesel oil**

Fuel used mainly by the transportation industry to power diesel engines.

**heating oil**

Fuel used in home heating systems and industrial installations requiring little energy.

**bunker oil**

Fuel used in high-powered heating systems and electric power plants; it is also used to power large diesel engines.

**greases**

Pasty substances made of mineral oil and soap; they are used by industry to lubricate mechanical parts.

**lubricating oils**

Viscous substances that are used mainly to reduce friction between two moving surfaces.

**paraffins**

Water-insoluble substances that have various uses; these include candle making, packaging and pharmaceutical products.

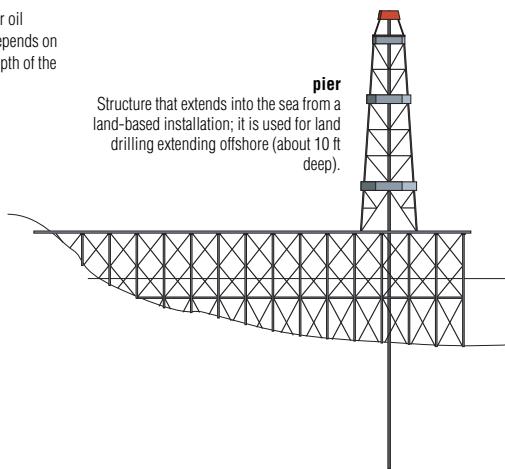
**asphalt**

Mixture of bitumen and other substances that is used mainly to pave roads.

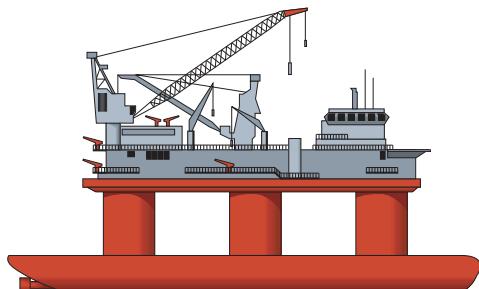
oil

**offshore drilling**

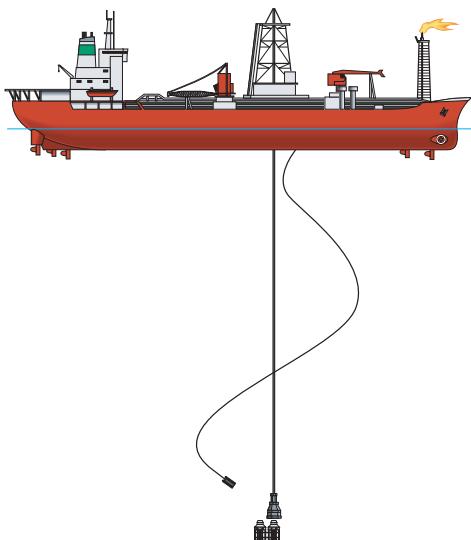
There are various types of underwater oil drilling installations; the one used depends on the location of the deposit and the depth of the water.

**emergency support vessel**

Floating structure equipped with specialized equipment; it is used for rescue operations on drilling rigs.

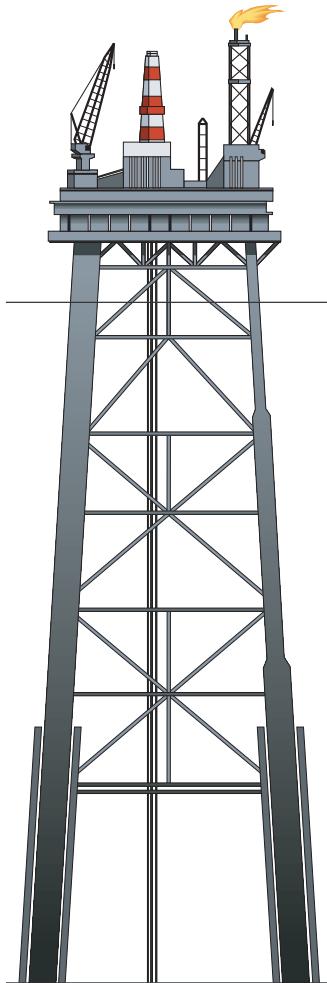
**drill ship**

Ship for drilling for oil in deep water (3,300 ft and more); it is more mobile but less stable than a semisubmersible or jack-up platform.

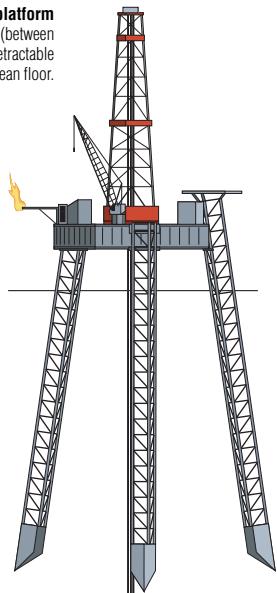


**fixed platform**

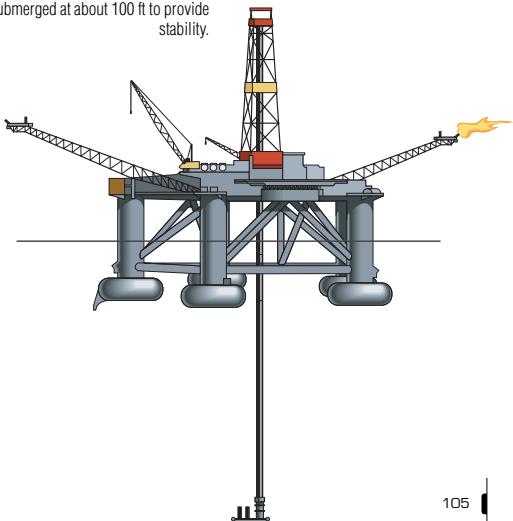
Structure that is mainly used at moderate depths (up to 1,300 ft); it rests on the seabed on pillars buried deep in the sea floor.

**jack-up platform**

Movable structure that is used in shallow water (between 65 and 330 ft); it is raised above sea level on retractable pillars resting on the ocean floor.

**semisubmersible platform**

Movable structure that is anchored to the seabed and used at depths of 350 to 1,650 ft; it is mounted on pontoons submerged at about 100 ft to provide stability.



oil

**crude-oil pipeline**

Continuous underground, aboveground or underwater oil pipeline that can be thousands of miles long (the Trans-Siberian pipeline is 3,800 mi long).

**derrick**

Metal structure erected over an oil well; tools for drilling through rock are raised and lowered through it.

**offshore well**

Hole dug in the sea floor to extract oil deposits; equipment such as the Christmas tree rests on the seabed.

**Christmas tree**

Group of devices at the head of the producing well that regulate the flow of oil being extracted from the deposit.

**buffer tank**

Large container that stores crude oil temporarily before it is pumped back into the pipeline.

**central pumping station**

Powerful pumping station that maintains the pressure required to move the oil along the pipeline to the next pumping station.

**aboveground pipeline**

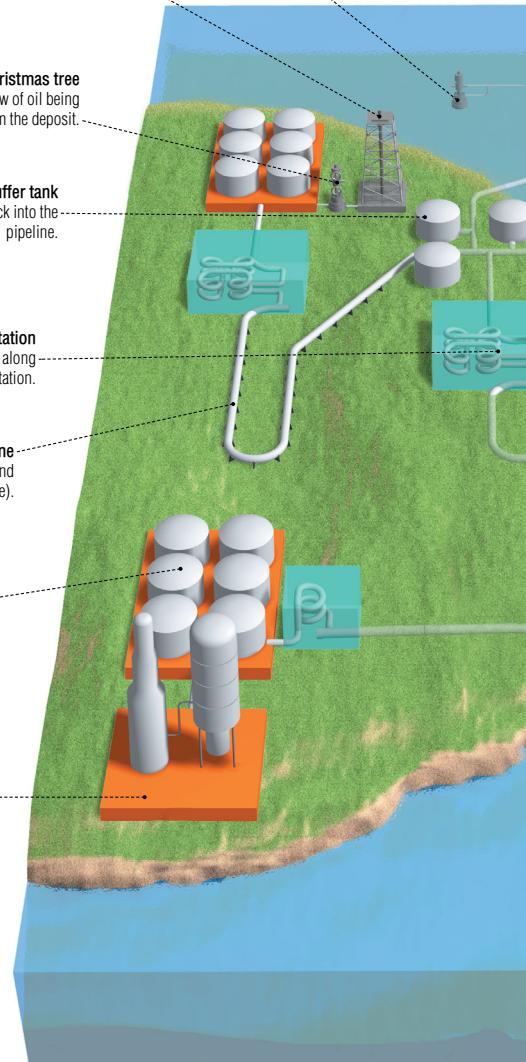
Oil pipeline that rests on aboveground supports to protect it from frozen ground (e.g., the Alaska pipeline).

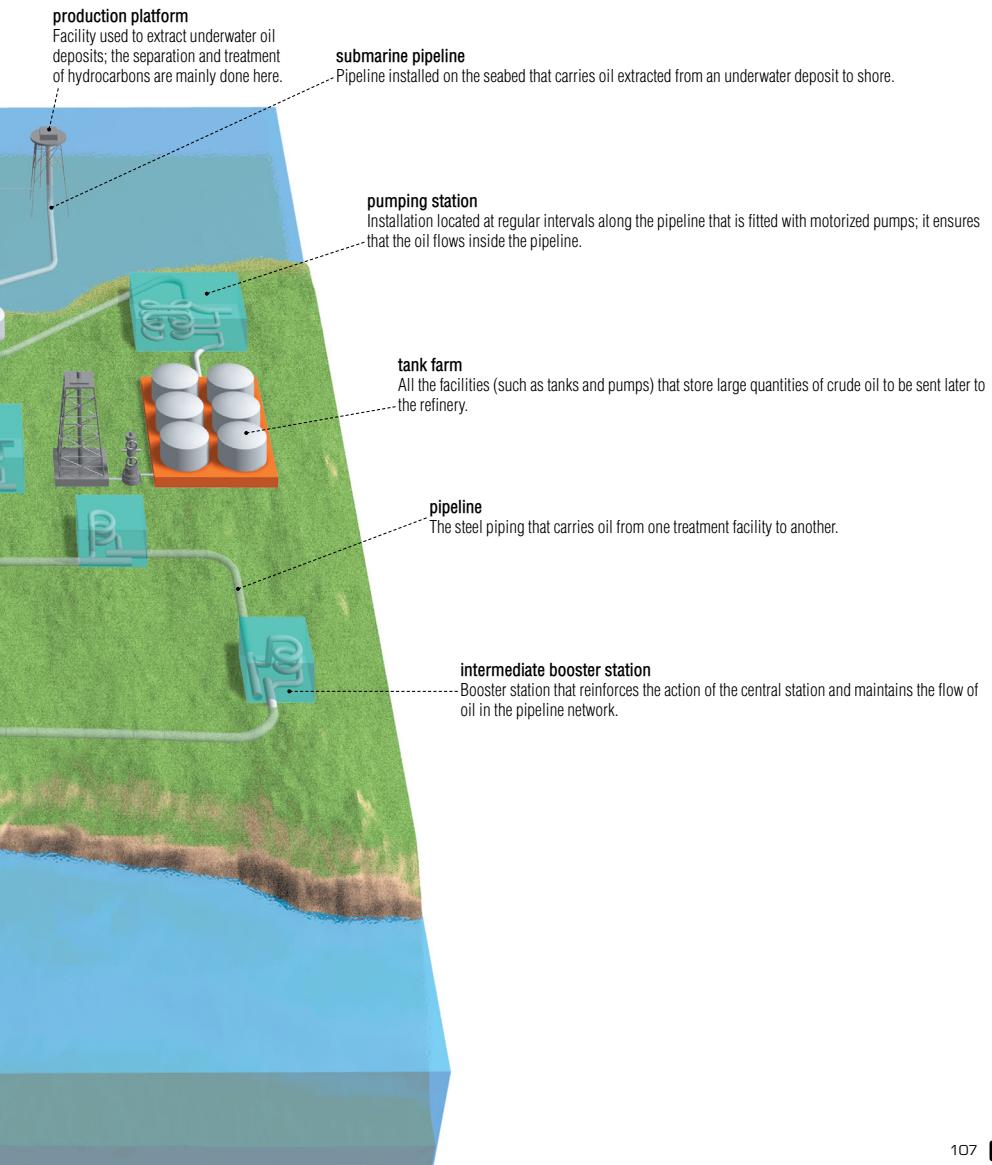
**terminal**

Facility located at the end of the pipeline that includes equipment such as tanks and pumps; it receives the crude oil before it is refined.

**refinery**

Plant in which crude oil is refined (separated and scrubbed) to obtain a broad range of finished products (including motor fuel and oils).





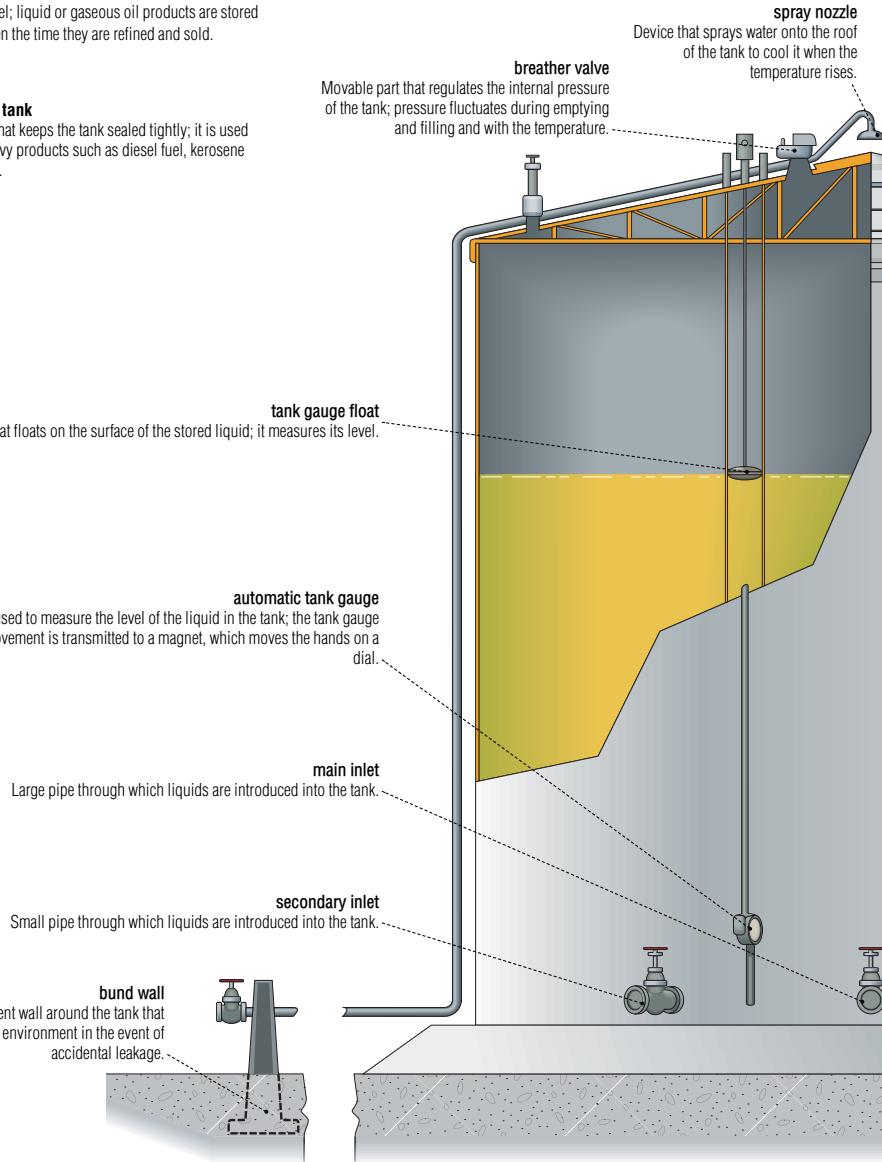
oil

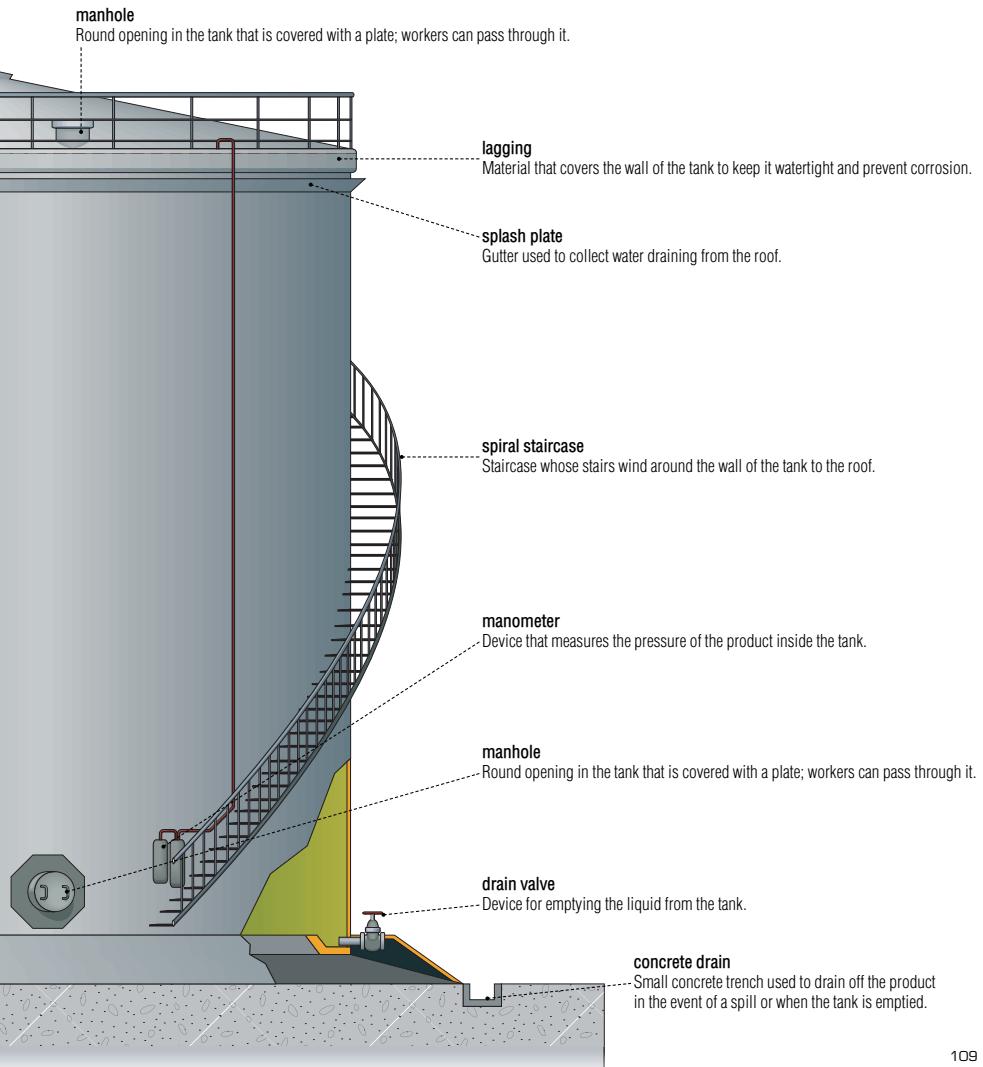
**tanks**

Large covered cylindrical containers that are usually made of steel; liquid or gaseous oil products are stored here between the time they are refined and sold.

**fixed-roof tank**

Fixed roof that keeps the tank sealed tightly; it is used to store heavy products such as diesel fuel, kerosene and asphalt.

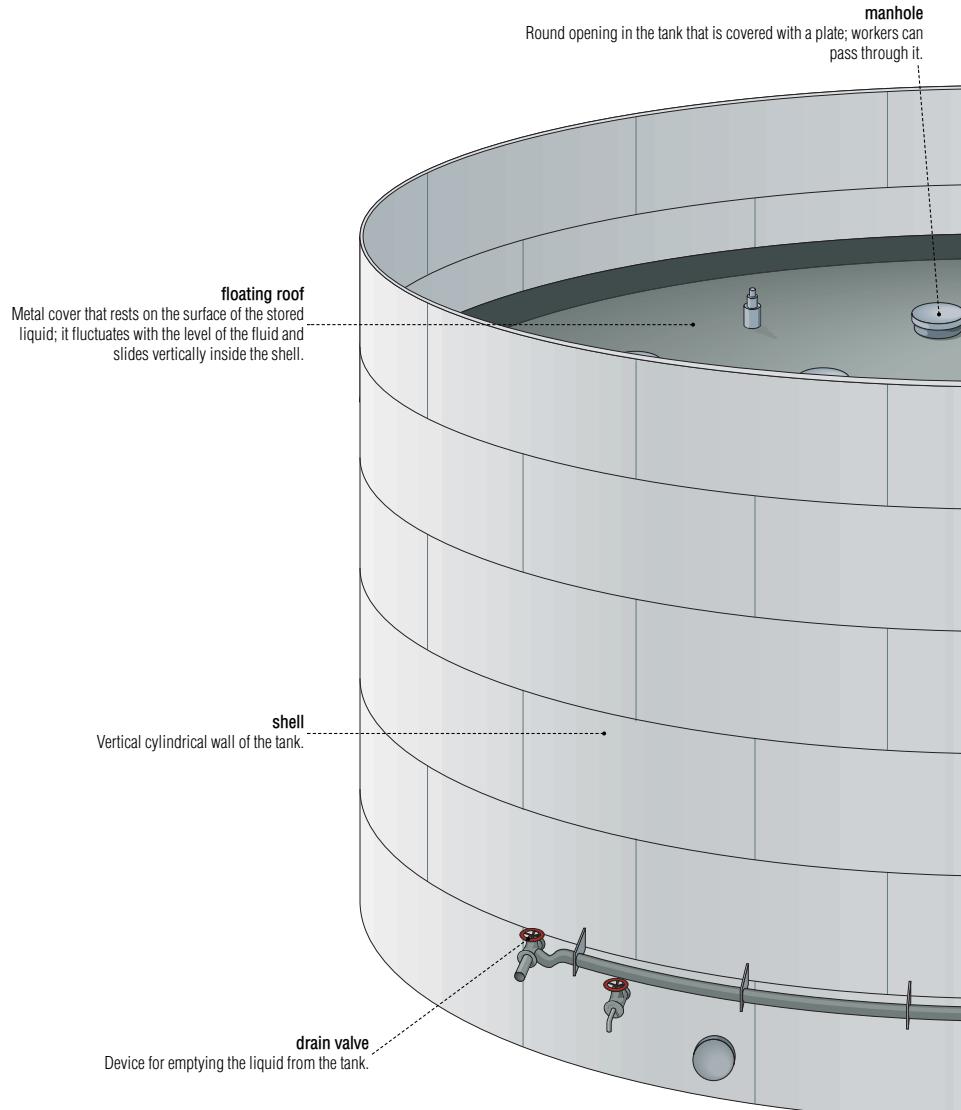


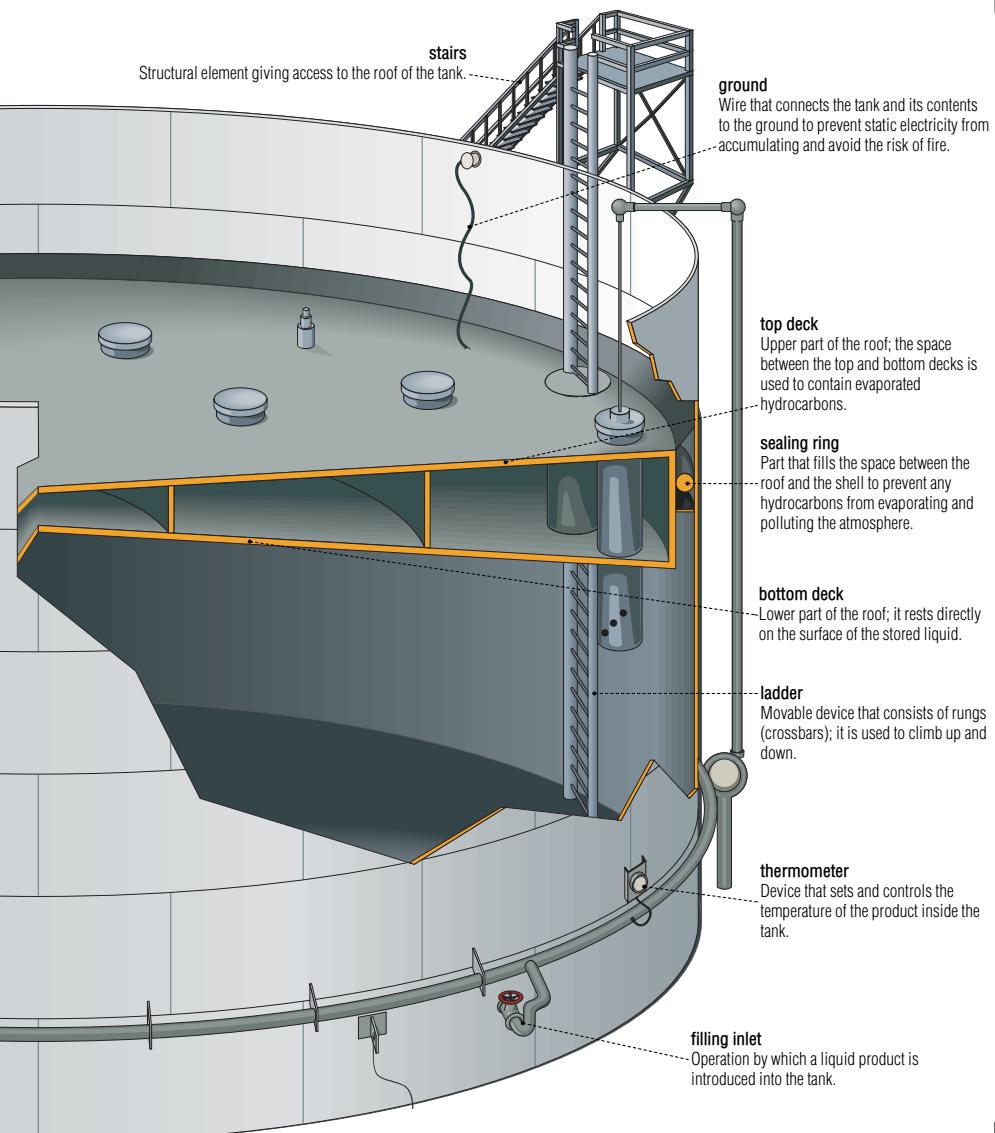


oil

**floating-roof tank**

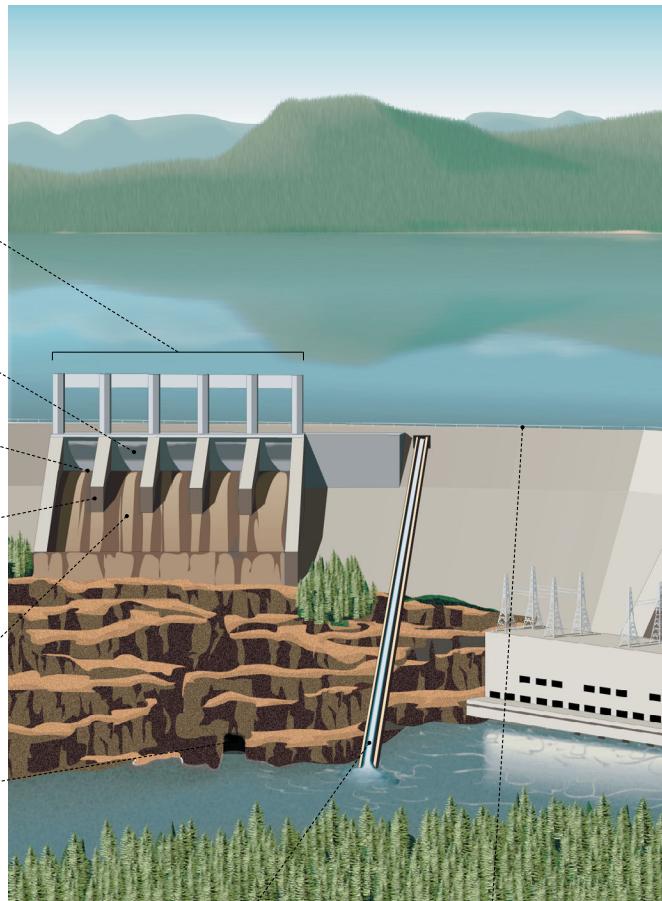
Tank whose floating roof rests directly on the surface of the liquid to minimize the evaporation of hydrocarbons; it is used to store the most volatile products.

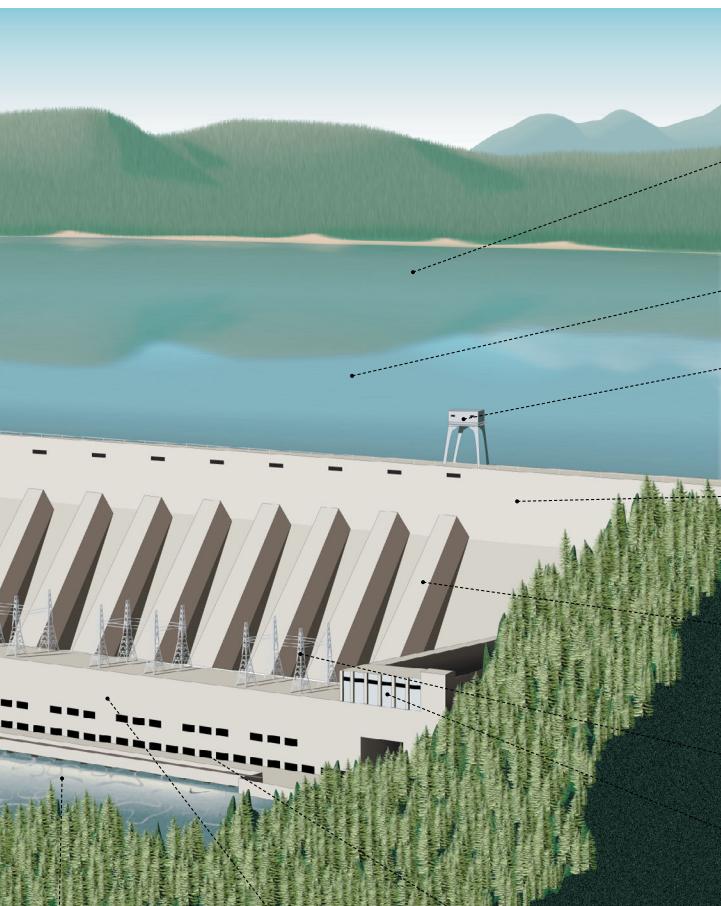




# hydroelectric complex

The reservoir structures and installations that use water power to produce electricity.



**afterbay**

Area of the watercourse where water is discharged after passing through the turbines.

**power plant**

Plant that uses an energy source, here water, and converts it into electricity.

**machine hall**

Area that houses the generator units used to produce electricity.

**reservoir**

Basin formed by the construction of a dam; it holds back a very large volume of water so that the flow rate can be controlled.

**headbay**

Part of the reservoir immediately in front of the dam where the current originates.

**gantry crane**

Hoisting device in the form of a bridge; it moves along rails.

**dam**

Barrier built across a watercourse in order to build up a supply of water for use as an energy source.

**penstock**

Channel that carries water under pressure to the power plant's turbines.

**bushing**

Device that allows the conductor to pass through the wall of the transformer and separates it from the latter.

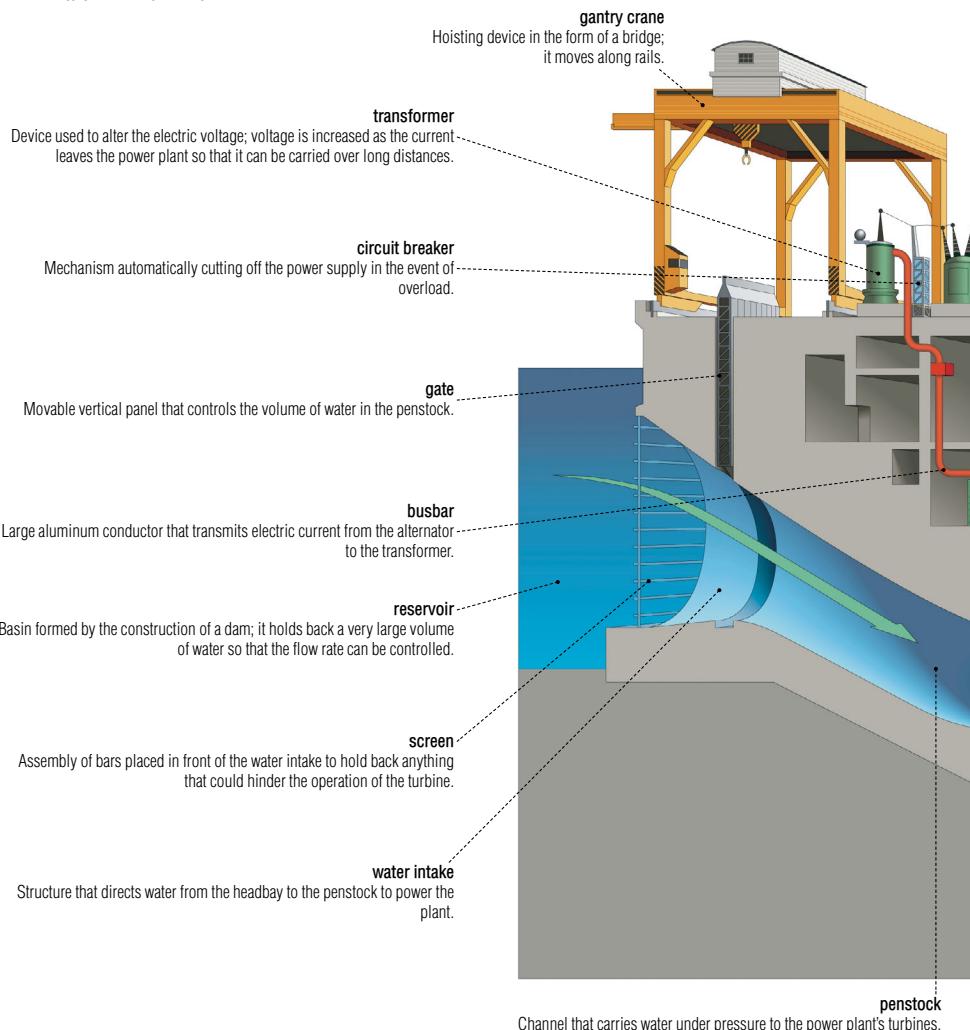
**control room**

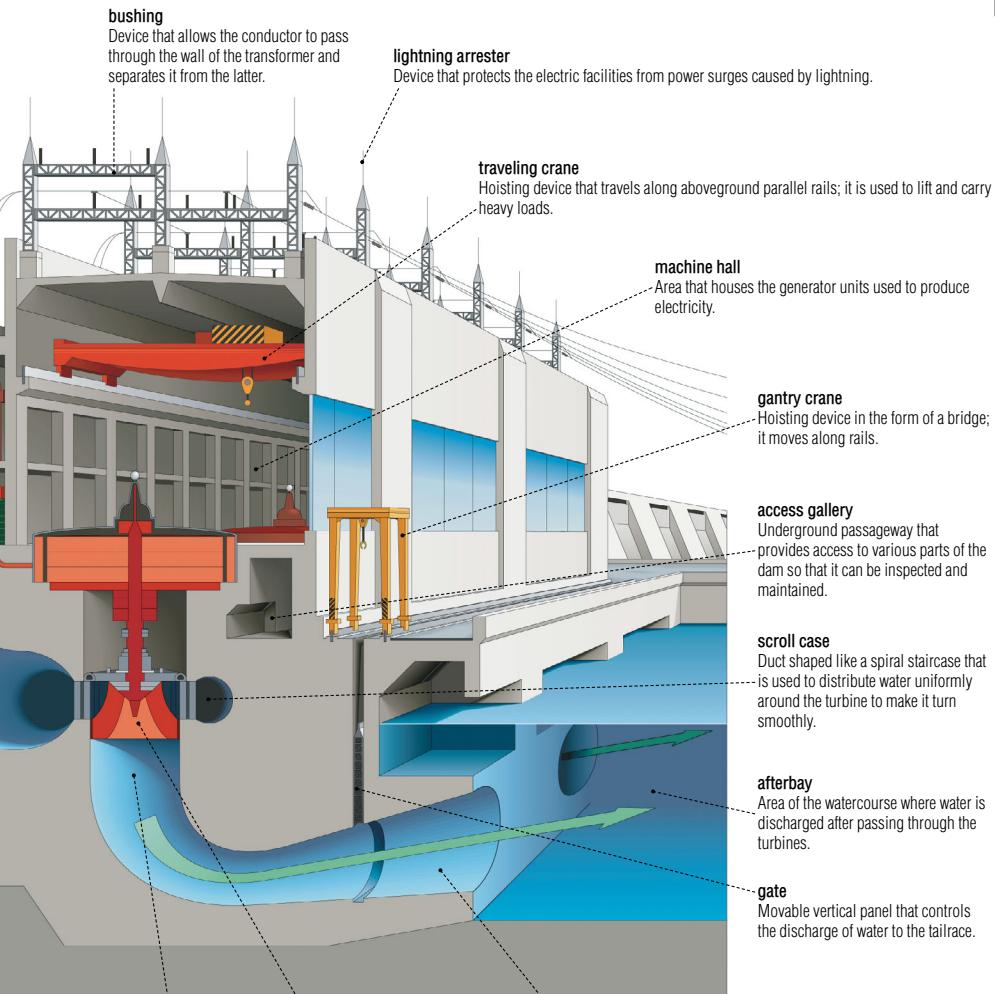
Area that contains the various control and monitoring devices required for the production of electricity.

## hydroelectric complex

## cross section of a hydroelectric power plant

Hydroelectric power plant: plant that produces electricity from energy generated by flowing water.



**bushing**

Device that allows the conductor to pass through the wall of the transformer and separates it from the latter.

**lightning arrester**

Device that protects the electric facilities from power surges caused by lightning.

**traveling crane**

Hoisting device that travels along aboveground parallel rails; it is used to lift and carry heavy loads.

**machine hall**

Area that houses the generator units used to produce electricity.

**gantry crane**

Hoisting device in the form of a bridge; it moves along rails.

**access gallery**

Underground passageway that provides access to various parts of the dam so that it can be inspected and maintained.

**scroll case**

Duct shaped like a spiral staircase that is used to distribute water uniformly around the turbine to make it turn smoothly.

**afterbay**

Area of the watercourse where water is discharged after passing through the turbines.

**gate**

Movable vertical panel that controls the discharge of water to the tailrace.

**draft tube**

Conduit at the base of the turbine that increases the runner's output by reducing the pressure of the water as it exits.

**generator unit**

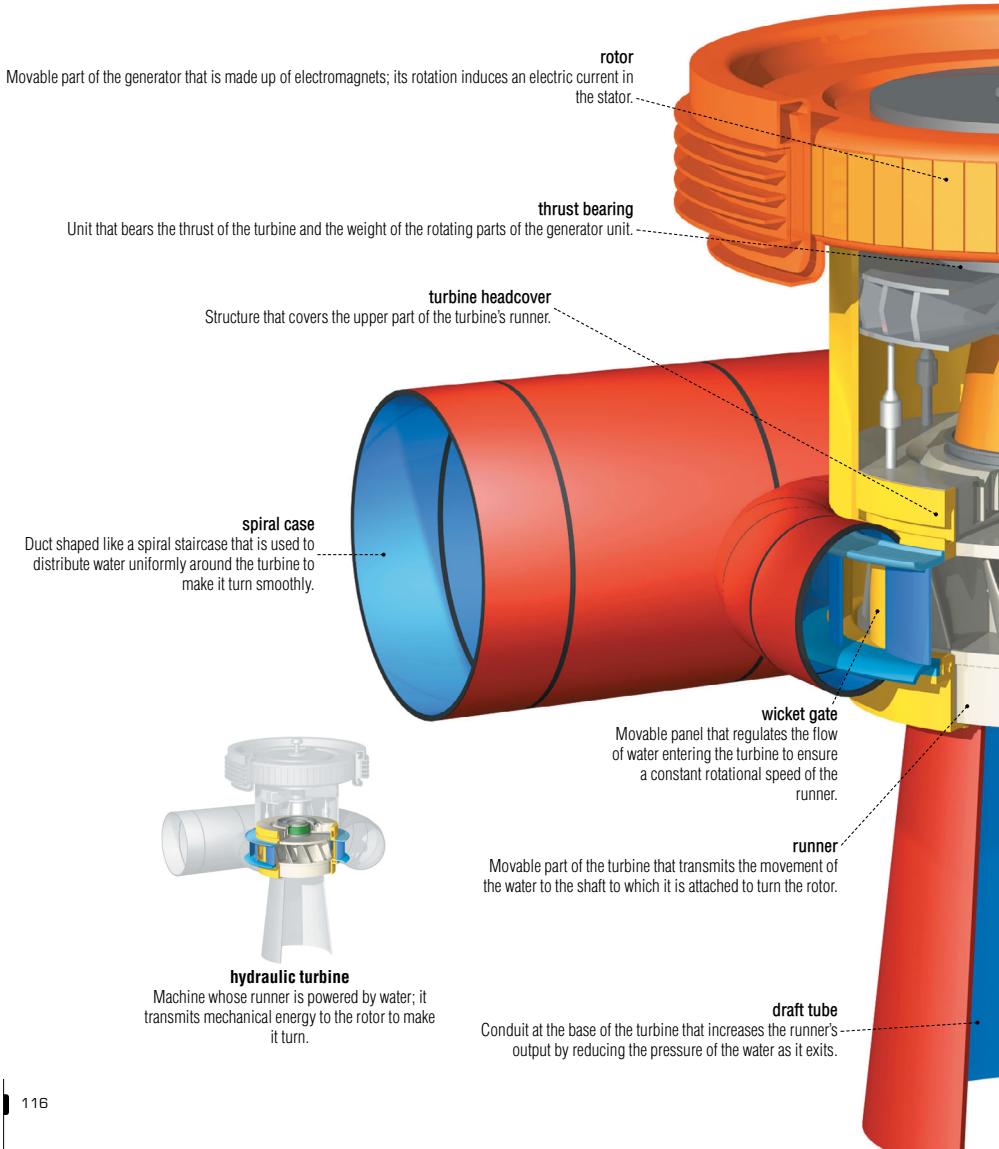
Device with a turbine that transmits the water's mechanical energy to the generator's rotor to make it turn to produce electricity.

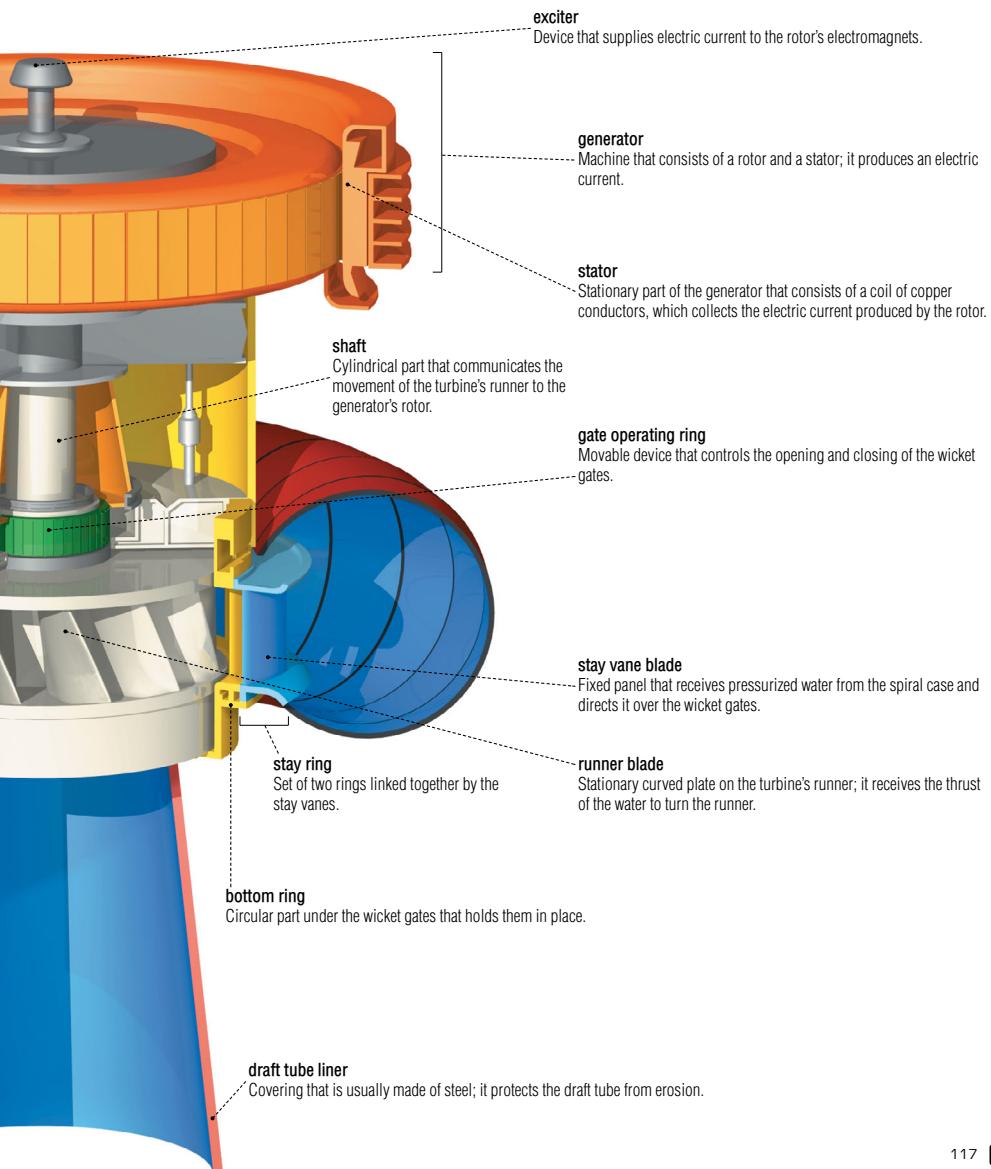
**tailrace**

Channel that discharges water toward the afterbay in order to return it to the watercourse.

## generator unit

Device with a turbine that transmits the water's mechanical energy to the generator's rotor to make it turn to produce electricity.





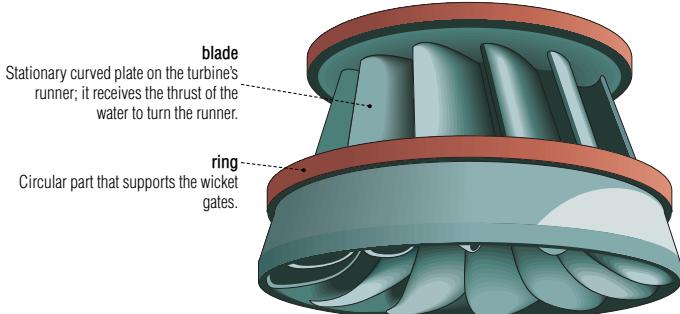
## generator unit

**runners**

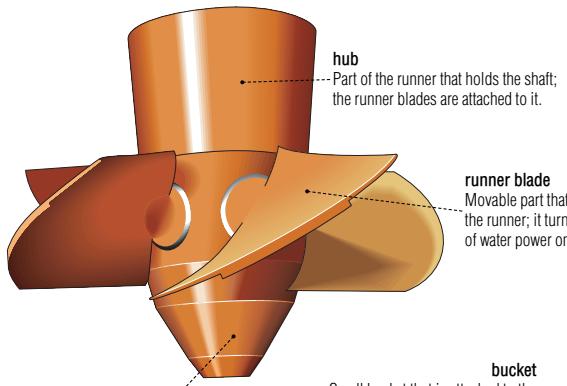
Movable parts of the turbine that transmit the movement of the water to the shaft to which they are attached to turn the rotor.

**Francis runner**

Most common type of runner that is suited to average heights of water (usually between 100 and 1,000 ft).

**Kaplan runner**

Type of runner that is suited to low heights of water (usually between 30 and 200 ft) and variable flow rates.

**Pelton runner**

Type of runner that is suited to high water sources (usually over 1,000 ft) and low flow rates.



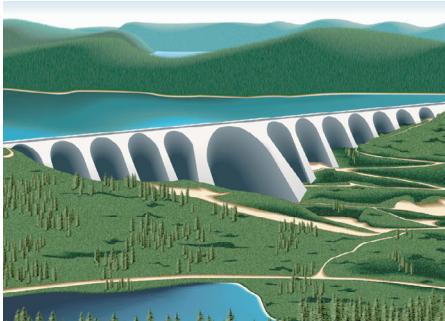
**bucket ring**  
Disk housing all the turbine buckets that activates the runner.



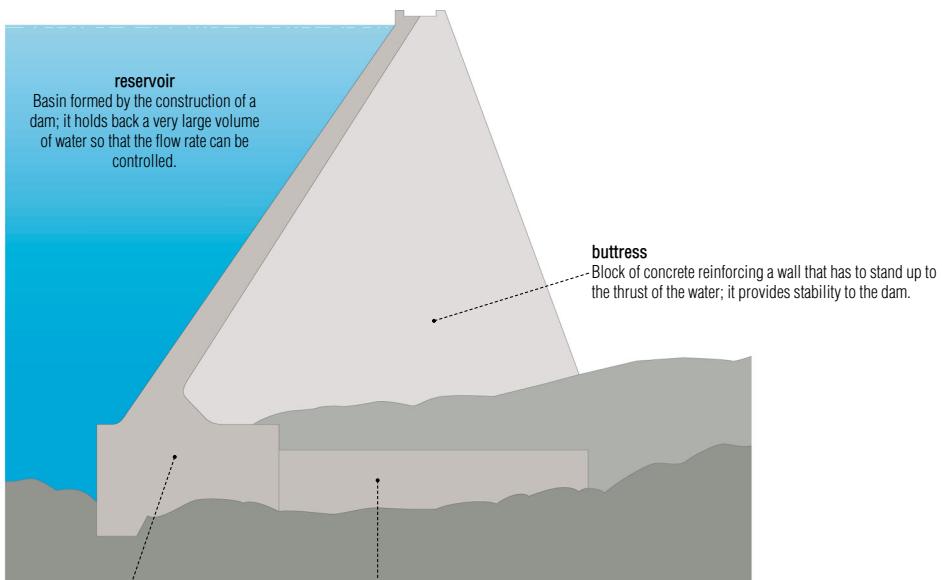
There are masonry dams, concrete dams and embankment dams; the choice depends on criteria such as the nature of the ground, the shape of the valley and the materials available.

### buttress dam

Used mainly in wide valleys, it consists of an impermeable wall, which is shored up by a series of buttresses to transmit the thrust of the water to the foundation.



**cross section of a buttress dam**



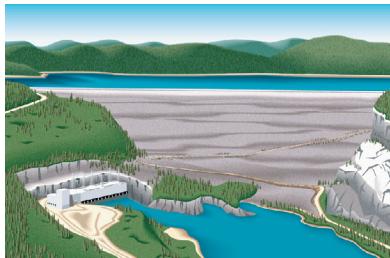
**foundation**  
Concrete structure that supports the weight of the dam and transmits it to the ground to provide stability to the dam.

**foundation blockage**  
Block of concrete that anchors the foundation in the ground to prevent movement.

## examples of dams

**embankment dam**

Formed of mounds of earth or rocks, it is used mainly when the subsoil does not allow for construction of a concrete dam.

**cross section of an embankment dam****reservoir**

Basin formed by the construction of a dam; it holds back a very large volume of water so that the flow rate can be controlled.

**pitching**

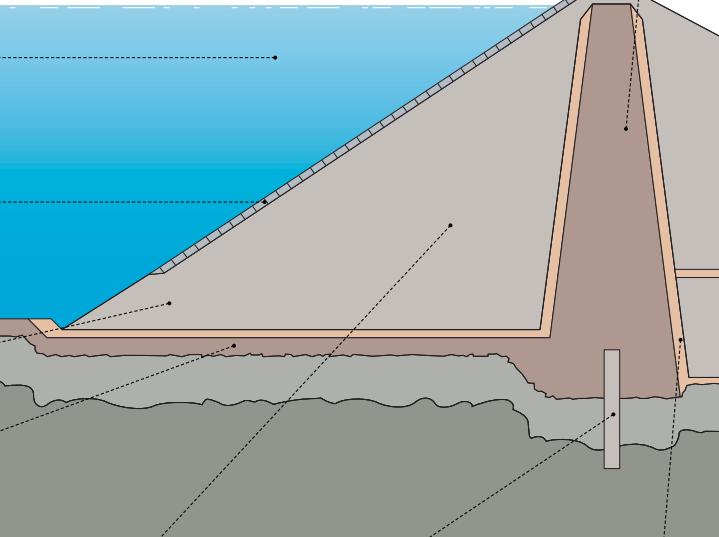
Layer of rock or concrete blocks that covers the upstream shoulder to prevent erosion.

**upstream toe**

Area where the upstream shoulder and the foundation of the dam meet.

**upstream blanket**

Impermeable layer that consists of compact clay; it rests on the bottom of the dam to prevent infiltration.

**upstream shoulder**

Soil embankment located on the reservoir side; its mass provides stability to the dam.

**cut-off trench**

Area of the foundation of the dam that is connected to the core; it contains impermeable materials to limit leakage and infiltration under the dam.

**clay core**

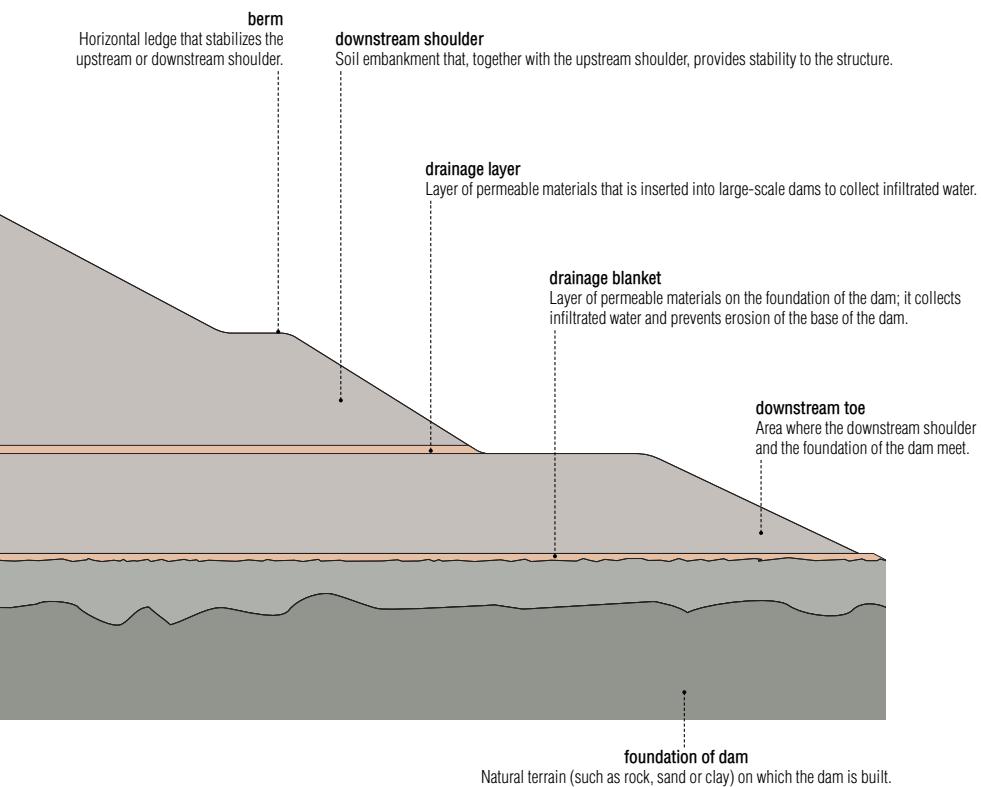
Central portion of the dam that is usually made of compact clay to make it watertight.

**top of dam**

Upper part of the dam; it rises above the water level of the reservoir by several yards.

**wave wall**

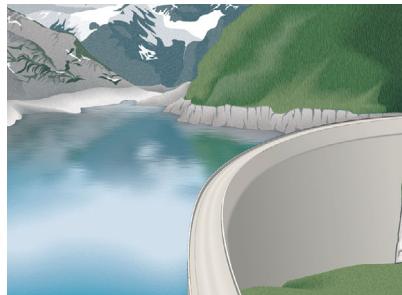
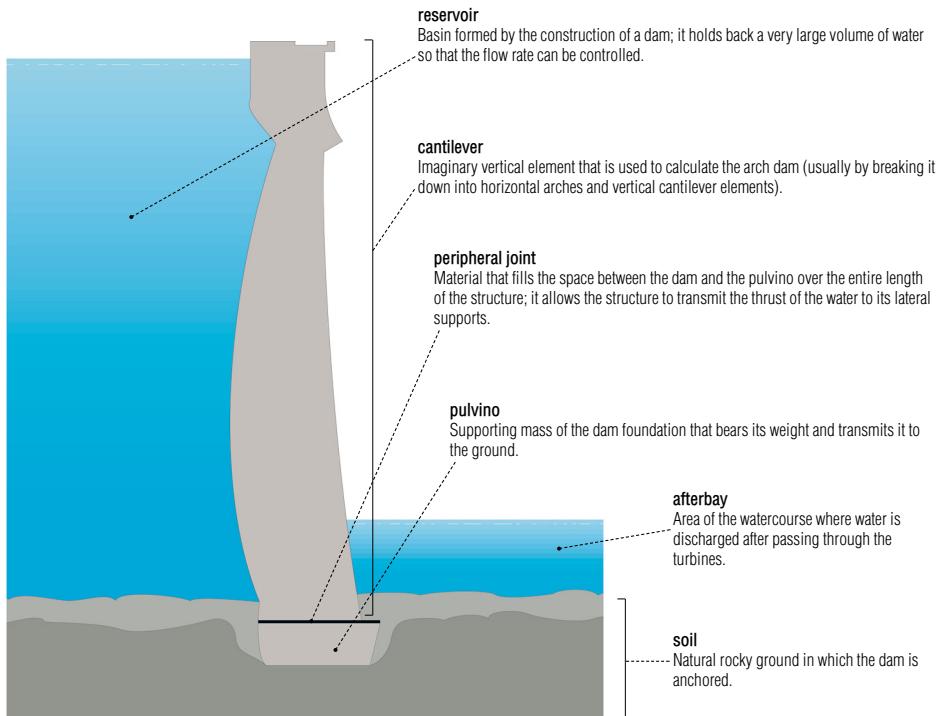
Small wall located at the top of the upstream shoulder that protects the dam against waves.



## examples of dams

**arch dam**

Its curvature allows most of the water's thrust to be transmitted to the usually narrow valley slopes supporting it.

**cross section of an arch dam**

**gravity dam**

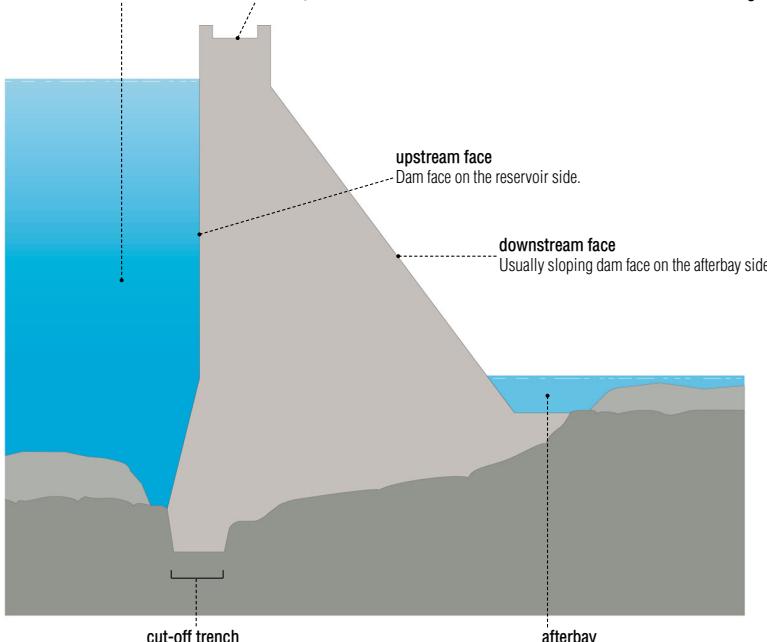
Its huge mass resists the thrust of the water to prevent it from overturning or sliding; this type of dam is usually used to hold back large volumes of water.

**reservoir**

Basin formed by the construction of a dam; it holds back a very large volume of water so that the flow rate can be controlled.

**top of dam**

Upper part of the dam that usually contains a roadway.

**cross section of a gravity dam**

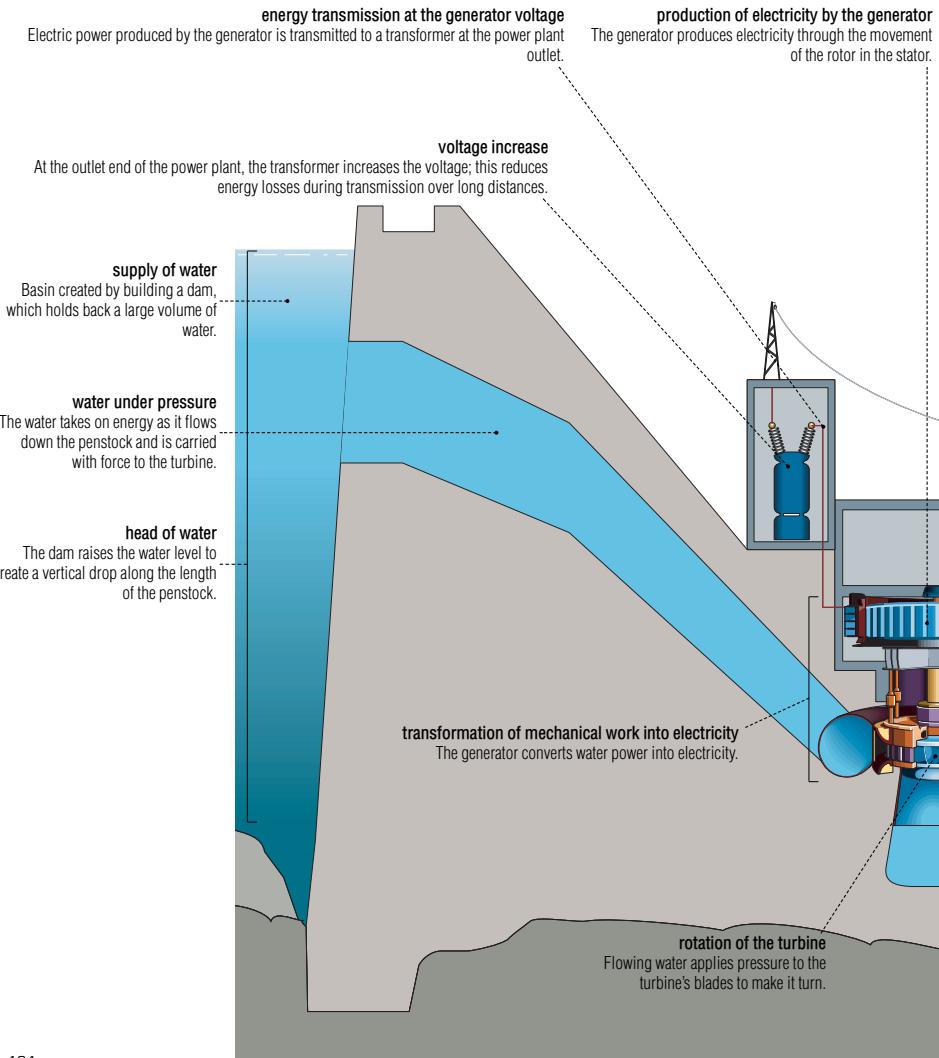
**Watertight structure that extends the foundations of the dam into the ground; it limits leakage and infiltration under the dam.**

**afterbay**

Area of the watercourse where water is discharged after passing through the turbines.

## steps in production of electricity

In a hydroelectric power plant, water is turned into electricity, which is carried to consumers along a transportation and distribution network.



**energy integration to the transmission network**

The electricity produced is integrated into the network.

**high-tension electricity transmission**

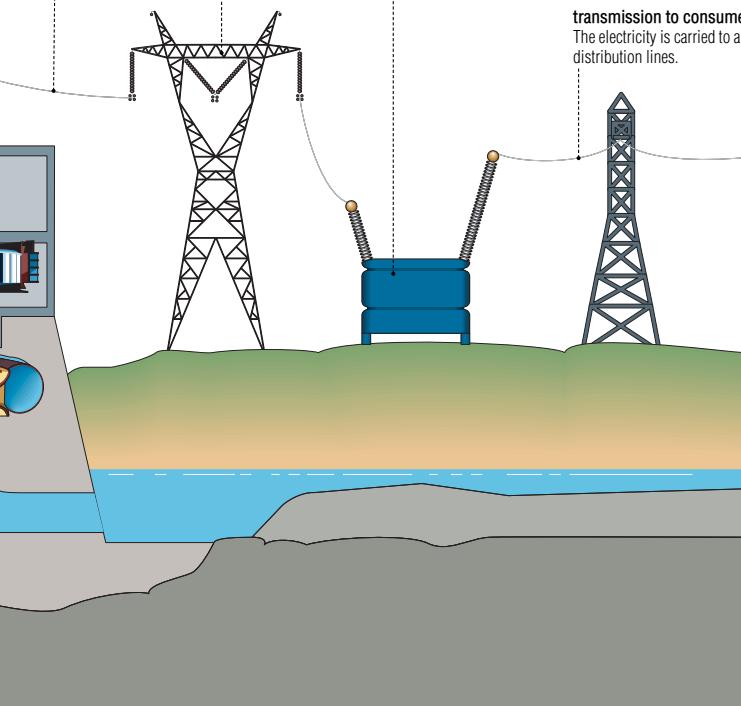
Using high-voltage lines to transmit electricity over long distances reduces the strength of the current and, as a result, energy losses.

**voltage decrease**

Before integrating the electricity into the distribution network, the voltage is progressively decreased to 240 V.

**transmission to consumers**

The electricity is carried to areas of consumption by low-voltage distribution lines.

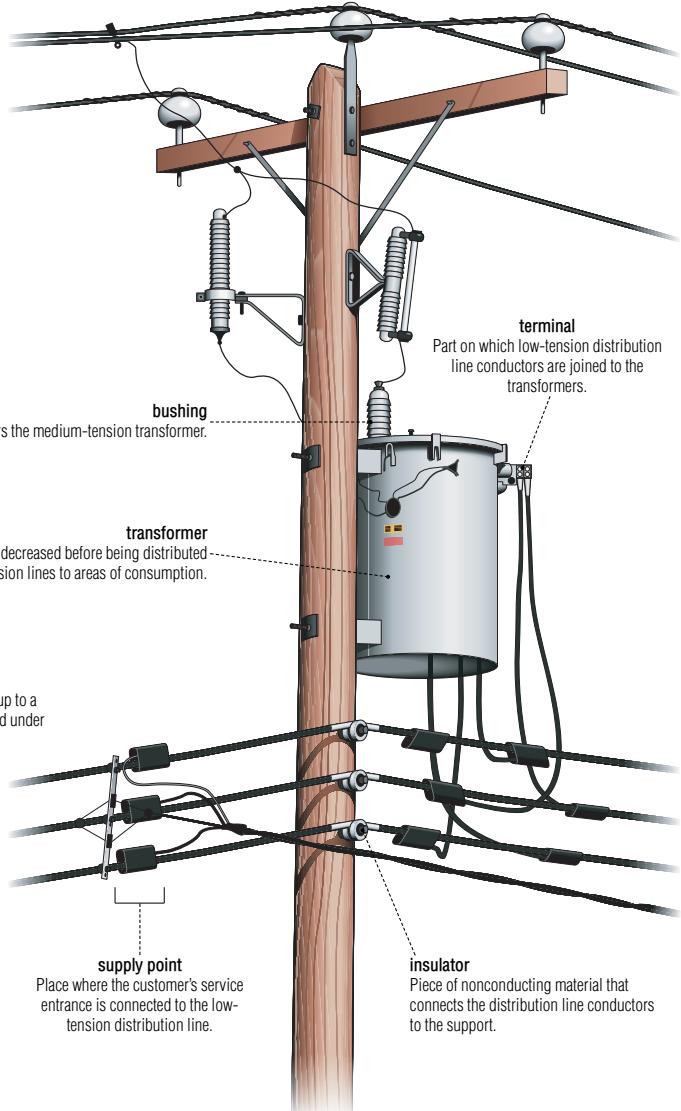


# electricity transmission

Electricity is carried by overhead and underground lines; due to high cost, underground lines are used mainly in cities.

## overhead connection

The equipment and overhead conductors that connect a subscriber's electric system to the public distribution network.



**medium-tension distribution line**

Overhead line that distributes electricity at a voltage between 750 and 50,000 V; its conductors are located at the top of electricity poles.

**brace**

Slanted part that connects the pole to the crossarm to hold it in place horizontally.

**hot line connector**

Linking piece with a bolt, which is tightened to bring together two conductors to establish an electric connection between them.

**insulator**

Piece of nonconducting material that connects the distribution line conductors to the support.

**crossarm**

Horizontal element located at the top of an electricity pole; insulators are attached to it.

**lightning arrester**

Device that protects the electric facilities from power surges caused by lightning.

**fuse holder**

Electric junction point where the fuse is attached and on which it articulates so the fuse can fall over.

**fuse cutout**

Unit that consists of a fuse and a fuse holder.

**fuse**

Protection device for the electric circuit; it falls from the fuse holder to cut the current in the event of a surge.

## electricity transmission

**pylon**

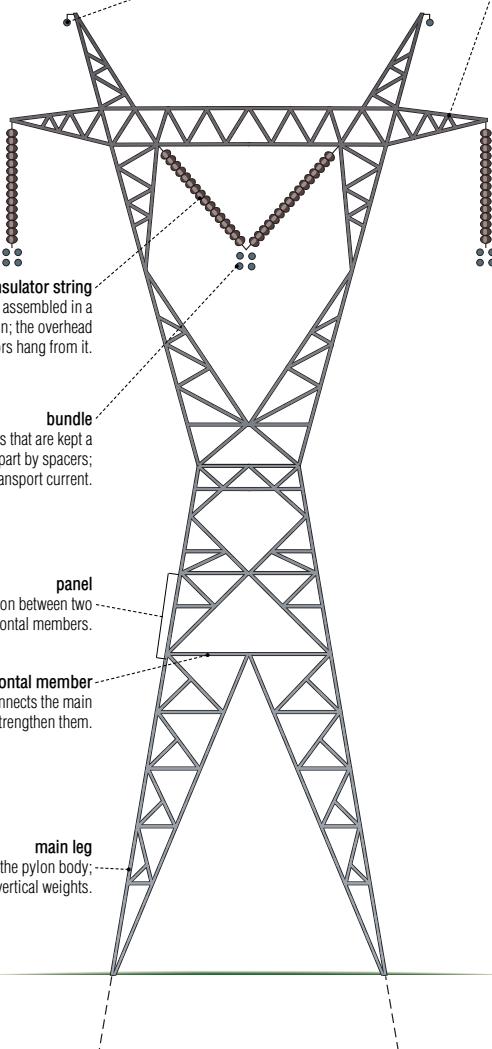
Metal beam that supports the electric conductors along the overhead transportation lines.

**overhead ground wire**

Conductor that is connected to the ground and attached above the bundles of the overhead lines to protect them from lightning.

**crossarm**

Horizontal element that protrudes on each side of the pylon; it supports the bundles by means of suspension insulator strings.

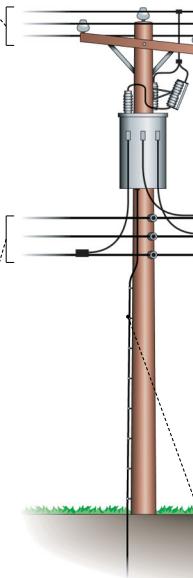


**network connection**

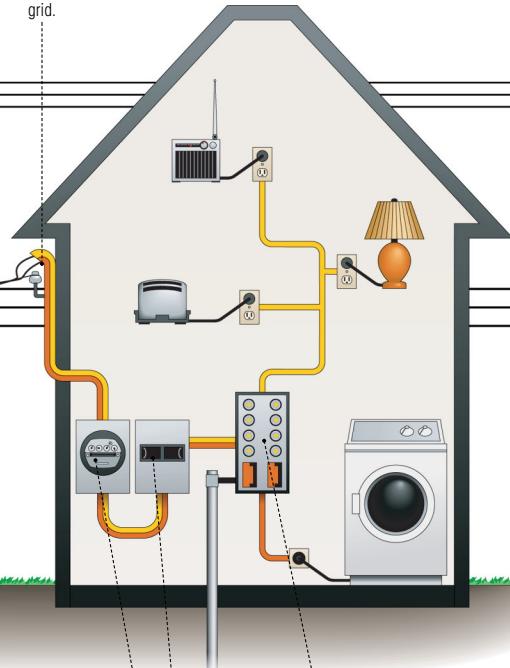
Set of equipment and conductors allowing a customer's electric installation to be connected to the public grid.

**medium-tension distribution line**

Overhead electricity-distribution lines with tension between 750 and 50,000 volts; its conductors are located at the top of the poles.

**connection point**

Place where the customer's electric hookup is connected to the electric grid.

**low-tension distribution line**

Overhead electricity-distribution line with a maximum tension of 750 volts; its conductors are located under the transformer.

**ground wire**

Metal conductor inserted into the ground ensuring that accidental electric leakages are conducted to the earth.

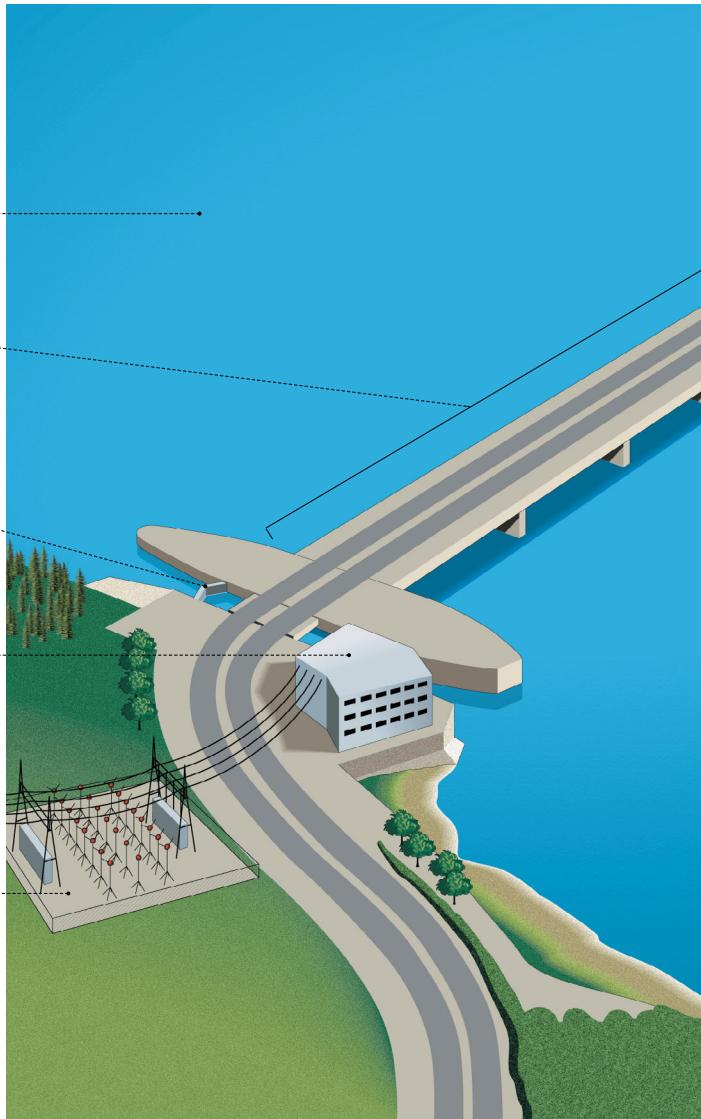
**electricity meter**  
Device measuring the consumption of electricity by a dwelling.

**distribution panel**  
Set of devices forming the junction of the public electricity grid and the electric circuits of a dwelling.

**main switch**  
Mechanism allowing a dwelling's current to be cut off.

## tidal power plant

Plant that harnesses tidal power (the motion of the rising and falling tides) to produce electric power.



sea

Vast body of saltwater at some distance inland; it is not as deep as an ocean.

power plant

Part of the dam housing bulb units that are powered by the rise and fall of the sea to produce electricity.

lock

Structure with doors and gates that is built between the sea and the basin; it allows boats to pass from one level to the other.

administrative building

substation

The devices (such as transformers and changeover switches) that increase the voltage of the electricity and carry it to the network.

**bank**

Strip of land bordering the sea.

**gate**

Movable vertical panel that controls the rate of flow of the water between the sea and the basin.

**operating dam**

Structure with gates that control the basin level in relation to the level of the sea.

**inactive dike**

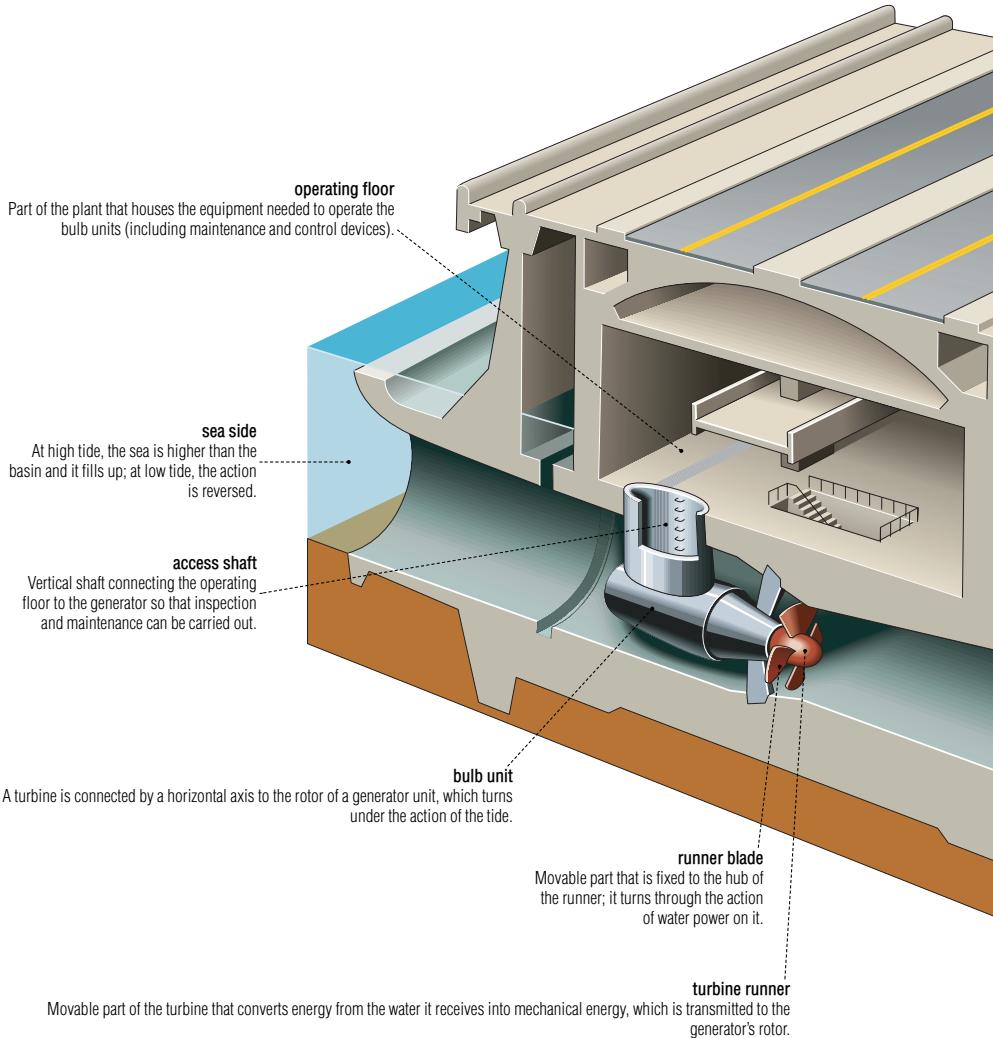
Part of the dam made up mainly of rocky material; it is built between the plant and the operating dam to separate the basin from the sea.

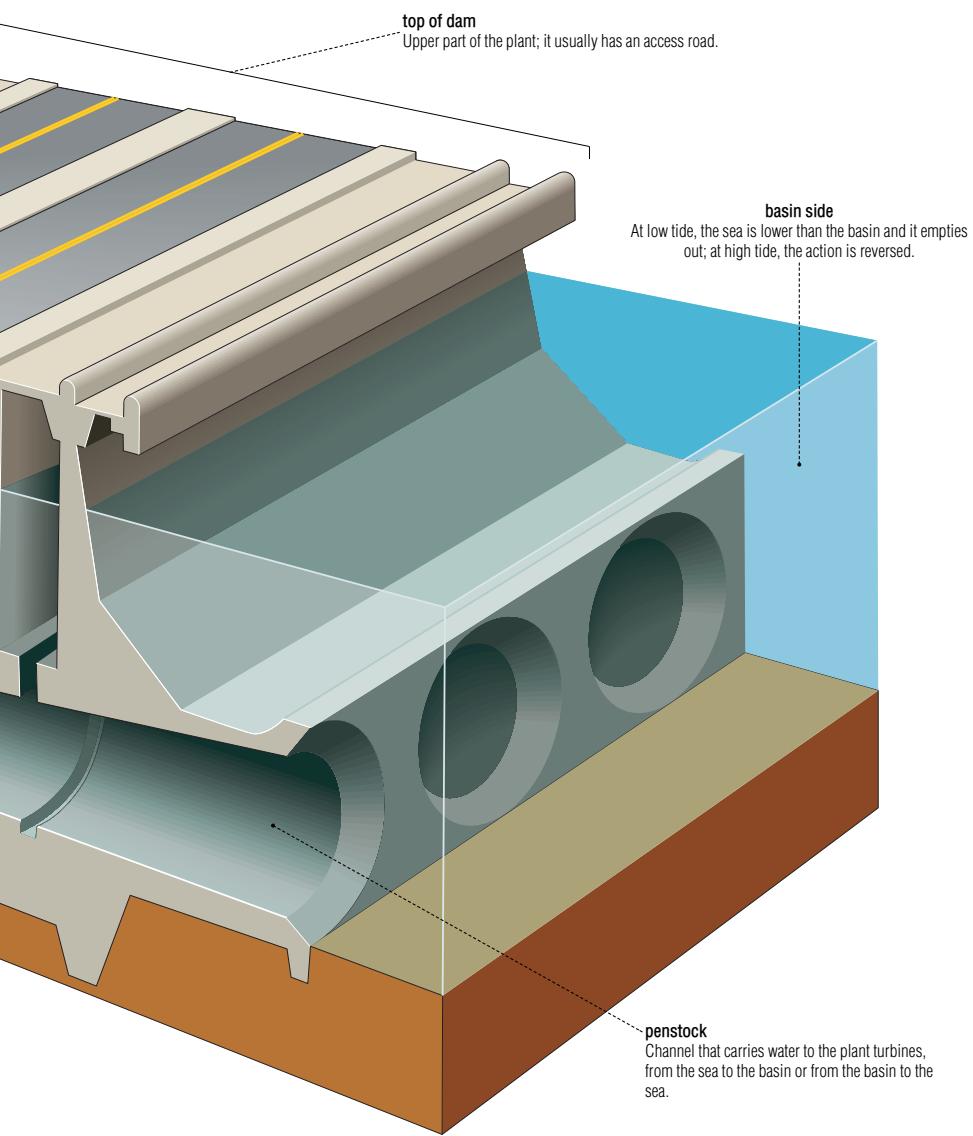
**basin**

Area in which water is stored at high tide; the basin empties out through the penstocks at low tide.

## tidal power plant

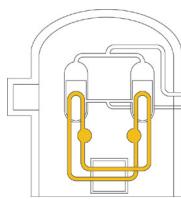
## cross section of a power plant





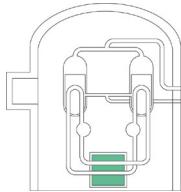
# production of electricity from nuclear energy

A nuclear fission chain reaction is started and controlled inside the reactor to produce electricity.



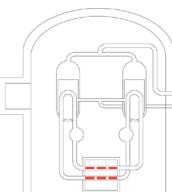
**coolant**

Liquid or gas (including heavy water and carbon dioxide) that circulates inside the reactor; it harnesses and transports the heat released during fission of the fuel.



**moderator**

Substance (ordinary water, heavy water, graphite) that slows the fast-moving neutrons emitted during fission to increase the probability of new collisions.

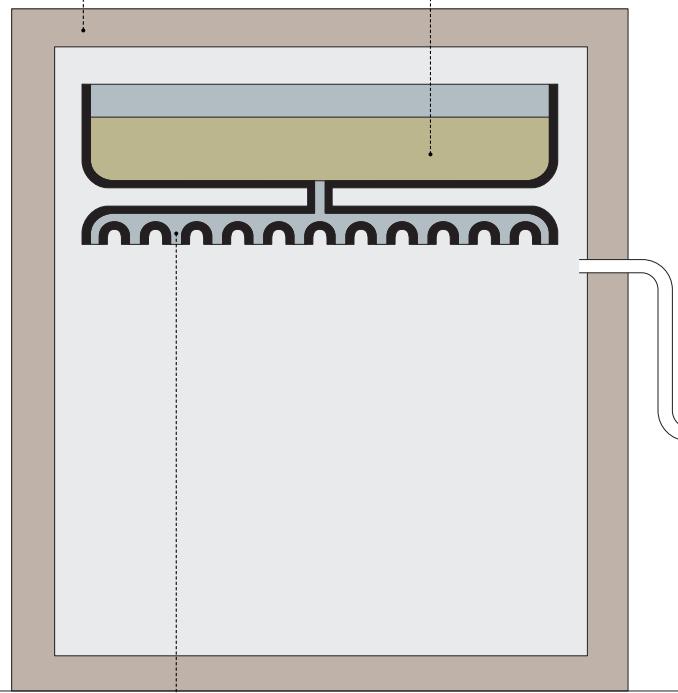


**fuel**

Matter placed in the core of the reactor that contains heavy atoms (uranium, plutonium); energy is extracted from it by fission.

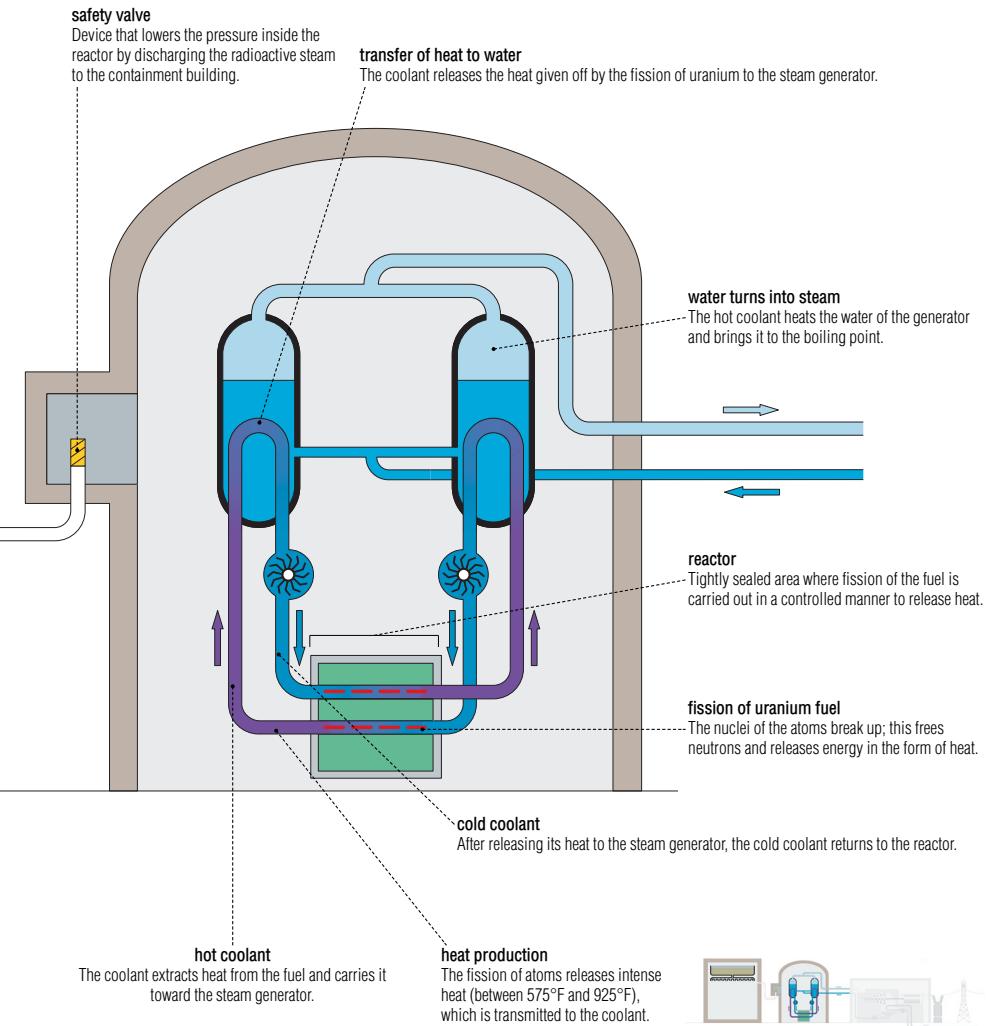
**containment building**  
Concrete building used to collect the radioactive steam from the reactor in the event of an accident.

**dousing water tank**  
Vat that contains water to cool the radioactive steam in the reactor in the event of an accident; this prevents a rise in pressure.



**sprinklers**

Devices that release water to condense radioactive steam.

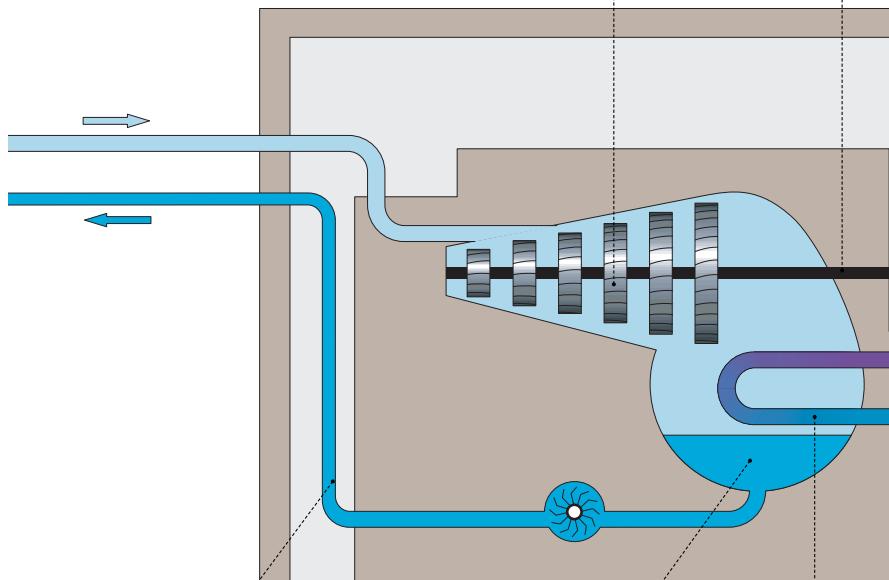


**turbine shaft turns generator**

The rotational movement of the turbine is transmitted to the generator's rotor.

**steam pressure drives turbine**

Steam from the steam generator turns the turbine runner, which is connected to the generator.

**water is pumped back into the steam generator**

After passing through the turbine, water produced by the condensation of the steam returns to the steam generator.

**condensation of steam into water**

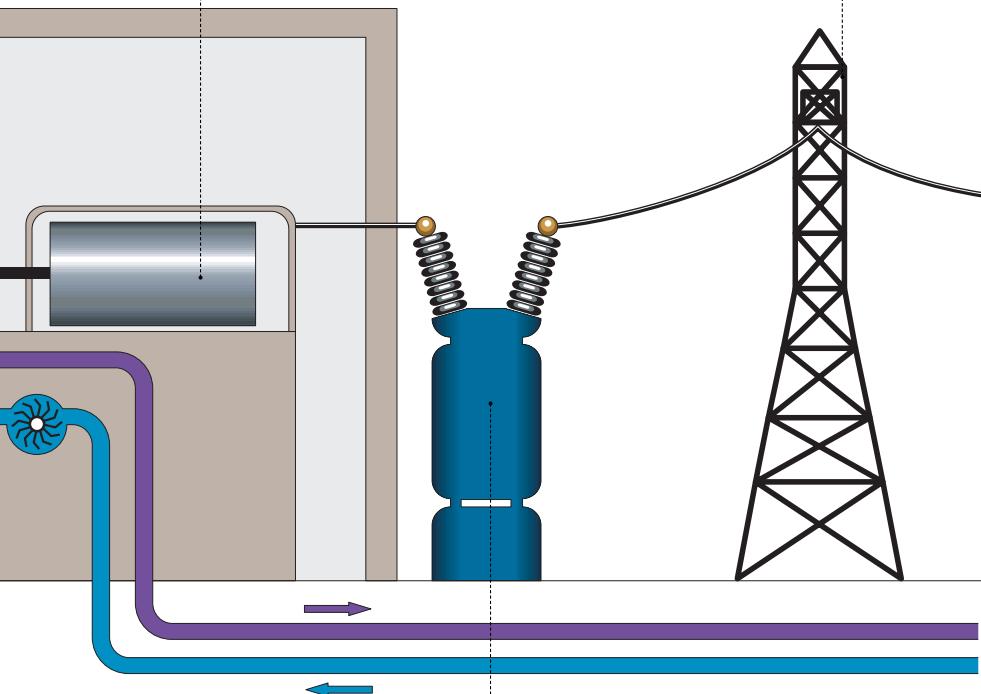
At the turbine outlet, the steam cools and condenses into water.

**water cools the used steam**

Cooling of the steam from the turbine is done with river or lake water.

**production of electricity by the generator**

The generator produces electricity through the movement of the rotor in the stator.

**electricity transmission**

Using high-voltage lines to transmit electricity over long distances reduces the strength of the current and, as a result, energy losses.

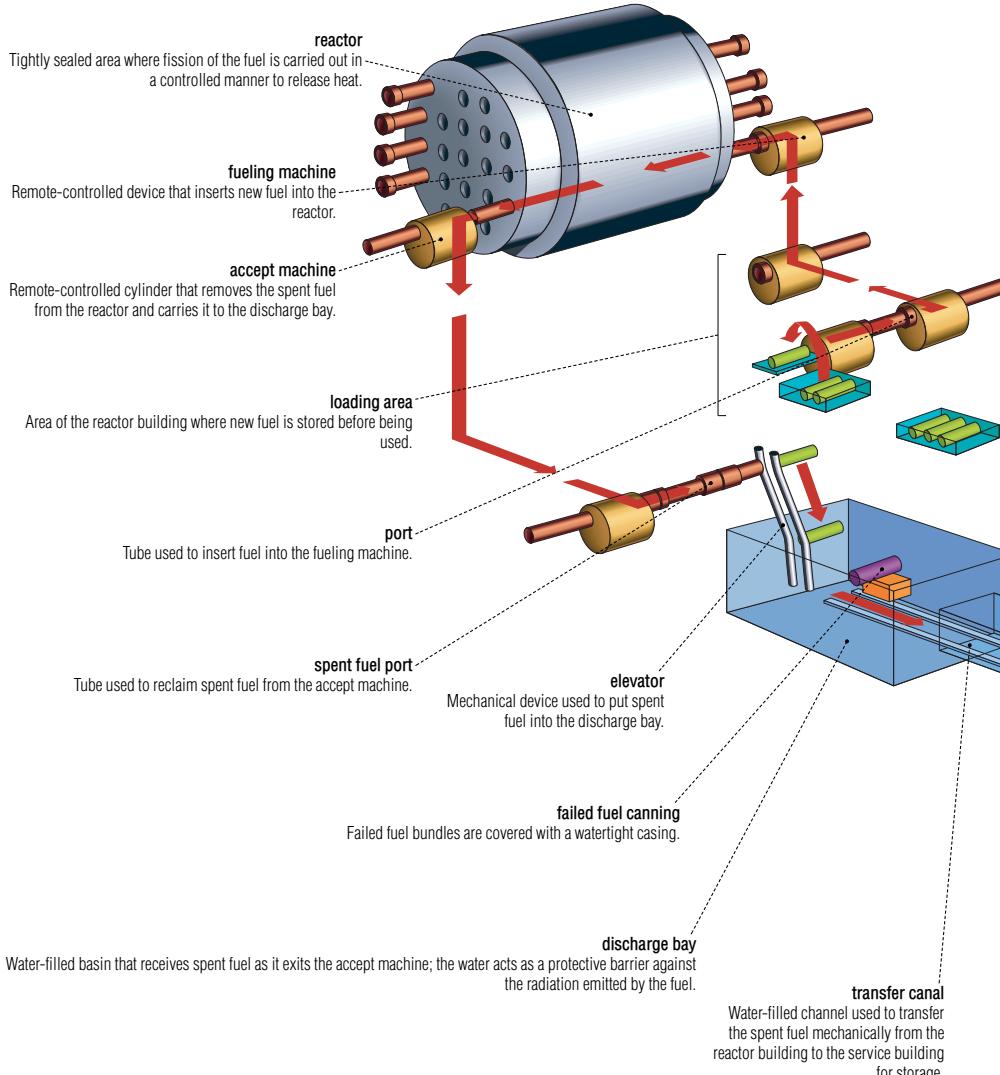
**voltage increase**

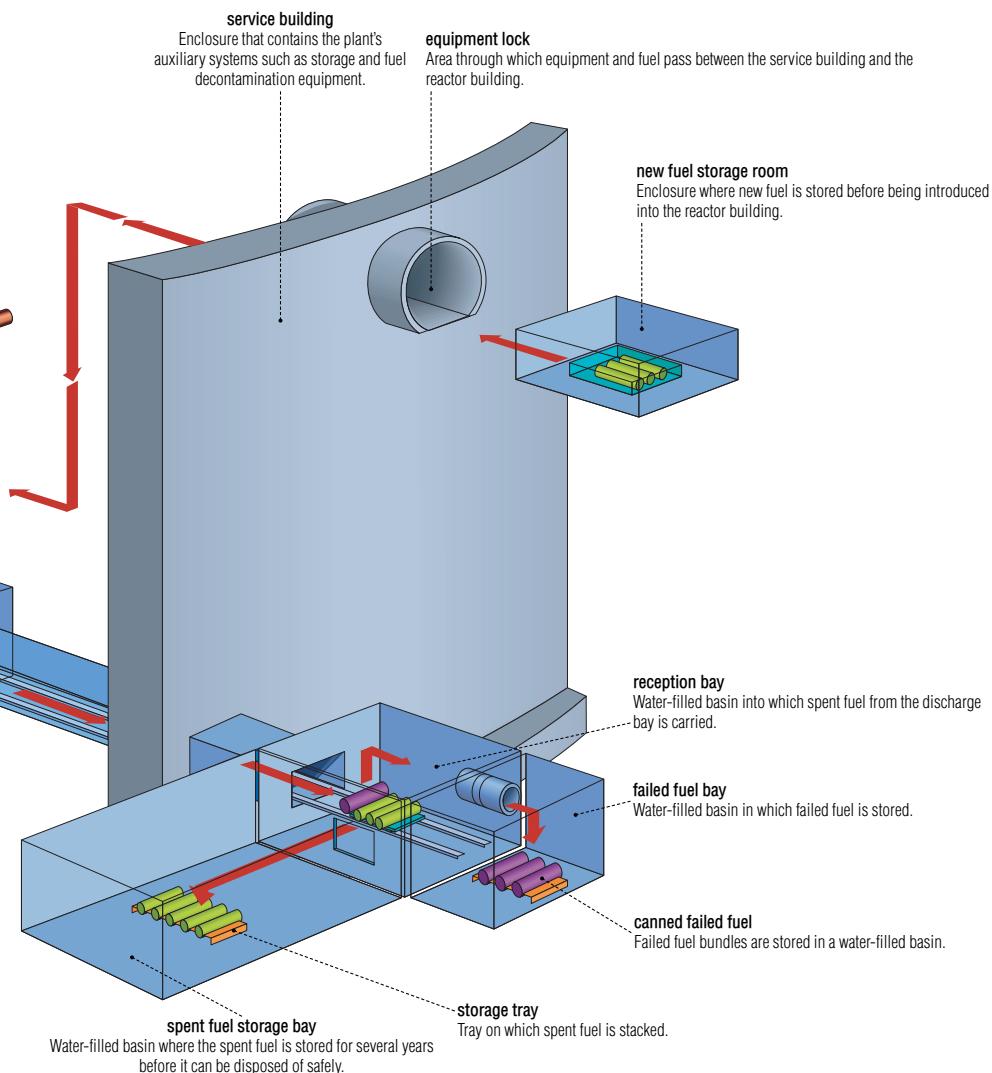
At the outlet end of the power plant, the transformer increases the voltage; this reduces energy losses during transmission over long distances.



## fuel handling sequence

Uranium is made into pellets, which are pressed into fuel bundles to be used in the reactor and then stored in cooling bays.





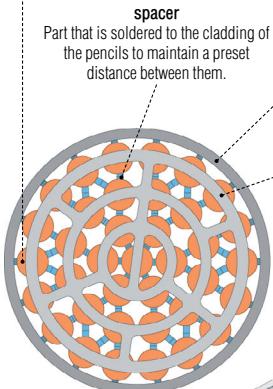
Water-filled basin where the spent fuel is stored for several years before it can be disposed of safely.

## fuel bundle

Fuel pencils that are grouped in parallel for introduction into the reactor.

### pencil

Watertight metal cladding in which fuel pellets are loaded.



### spacer

Part that is soldered to the cladding of the pencils to maintain a preset distance between them.

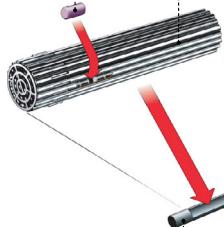
Tightly sealed area where fission of the fuel is carried out in a controlled manner to release heat.

**fuel pellet**

Small quantity of fuel that consists of powder pressed into a sheathing tube and then inserted into the metal cladding of the pencil.

**fuel bundle**

Fuel pencils that are grouped in parallel for introduction into the reactor.


**pressure tube**

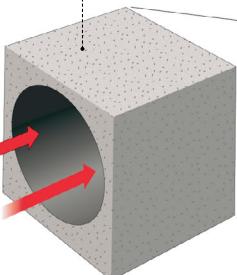
Tube that holds the fuel bundles and circulates the coolant at a preset pressure.


**reactor vessel**

The core of the nuclear reactor consists of tubular spaces where fission is produced and the coolant and moderator circulate.

**containment building**

Concrete structure surrounding the reactor vessel; it is a protective barrier against radioactivity.


**reactor building**

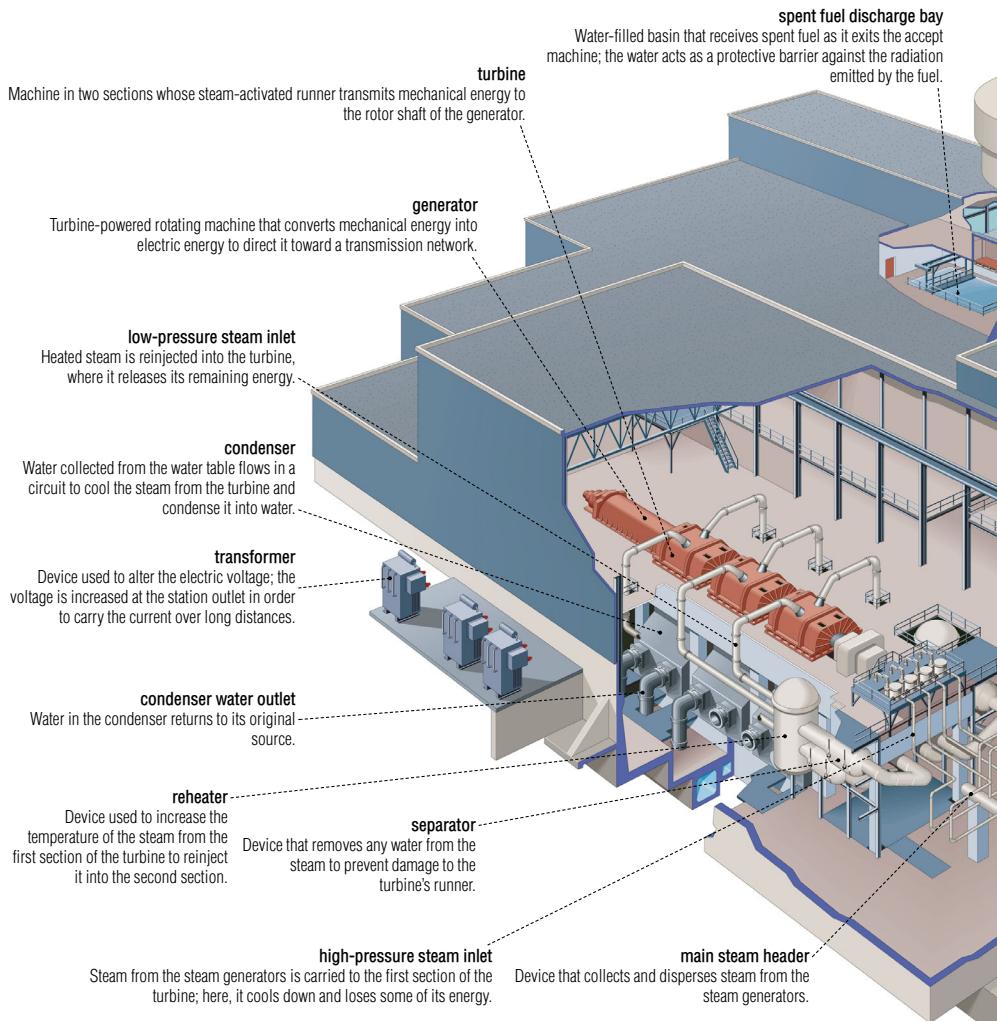
Concrete structure surrounding the reactor vessel; it is a protective barrier against radioactivity.

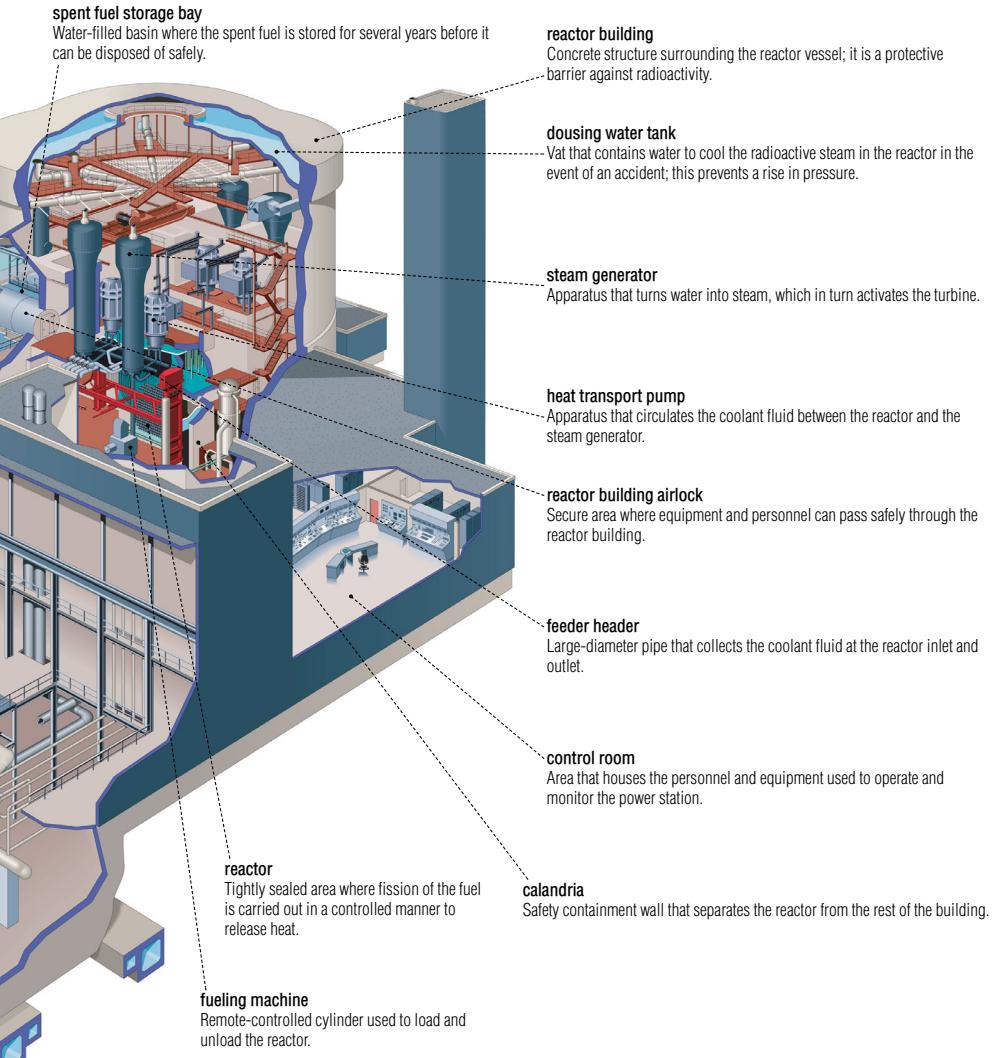

**spent fuel storage bay**

Water-filled basin where the spent fuel is stored for several years before it can be disposed of safely.

# nuclear generating station

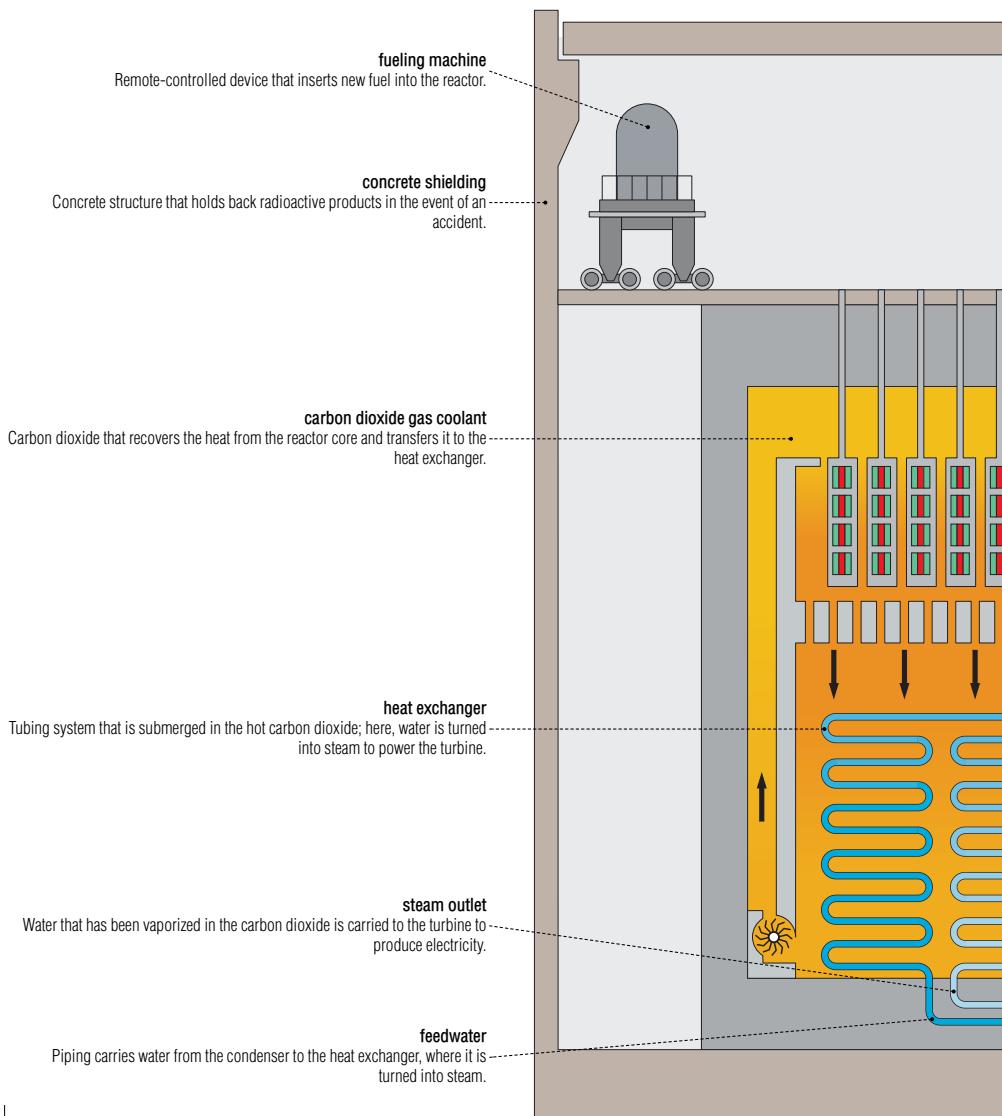
Plant that produces electricity from thermal energy generated by the fission of fuel atoms in a reactor.

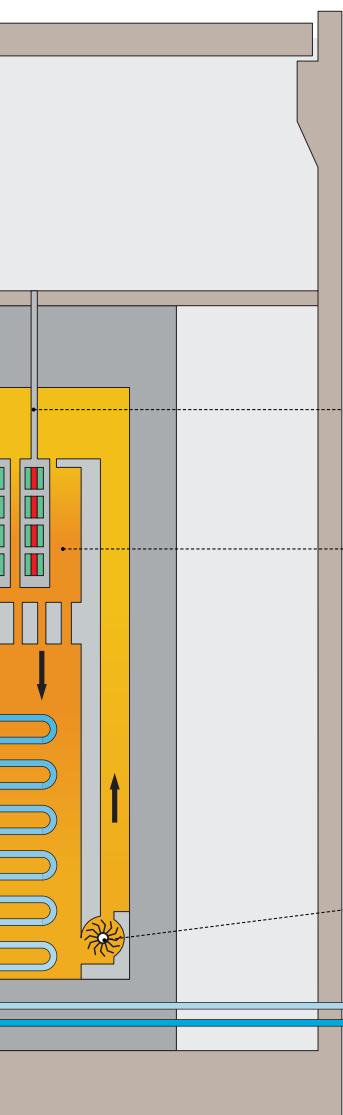




## carbon dioxide reactor

Developed for the most part in Great Britain and France, it was replaced by the pressurized water reactor, which performs better and is less expensive.



**control rod**

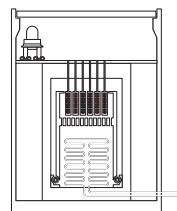
Tube that contains a neutron-absorbing material (boron, cadmium) that is introduced into the reactor core to control its power.

**reactor core**

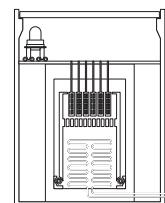
Center section of the nuclear reactor where fission reactions take place.

**blower**

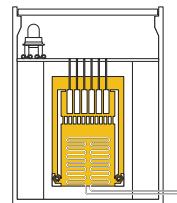
Device that circulates carbon dioxide in the reactor core.

**fuel: natural uranium**

Natural uranium: fuel extracted from mines; it consists of a mixture of three uranium isotopes (uranium-234, -235 and -238).

**moderator: graphite**

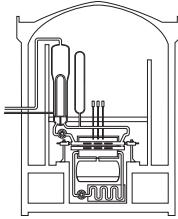
Moderator: medium that slows the speed of the neutrons to maintain a continuous chain reaction.

**coolant: carbon dioxide**

Carbon dioxide: gas that is heavier than air and is produced by burning graphite.

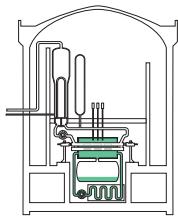
## heavy-water reactor

The advantage of this type of reactor is that it does not require fuel enrichment; it is used mainly in Canada, Argentina and India.



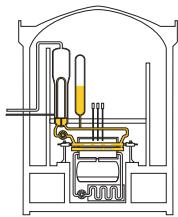
**fuel: natural uranium**

Natural uranium: fuel extracted from mines; it consists of a mixture of three uranium isotopes (uranium-234, -235 and -238).



**moderator: heavy water**

Heavy water: water consisting of heavy hydrogen (deuterium) and oxygen; it can slow down neutrons.



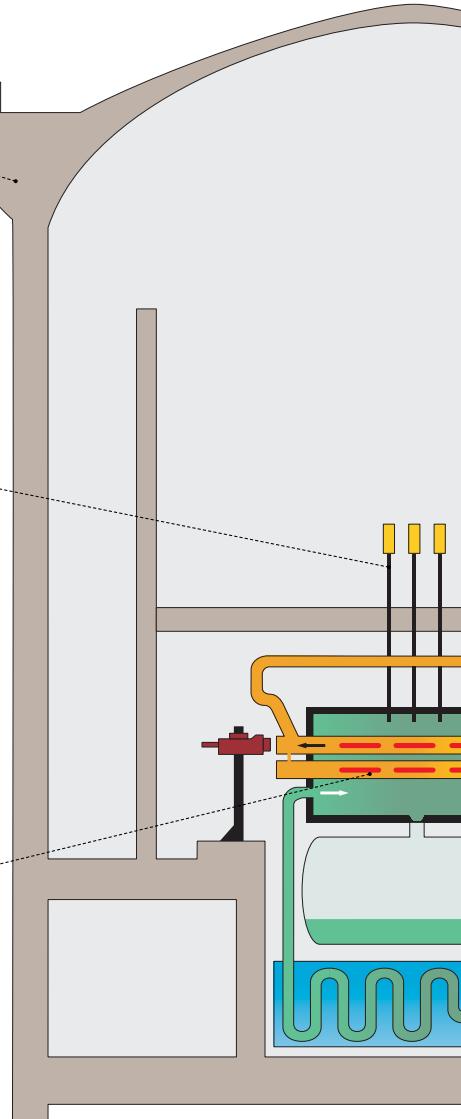
**coolant: pressurized heavy water**

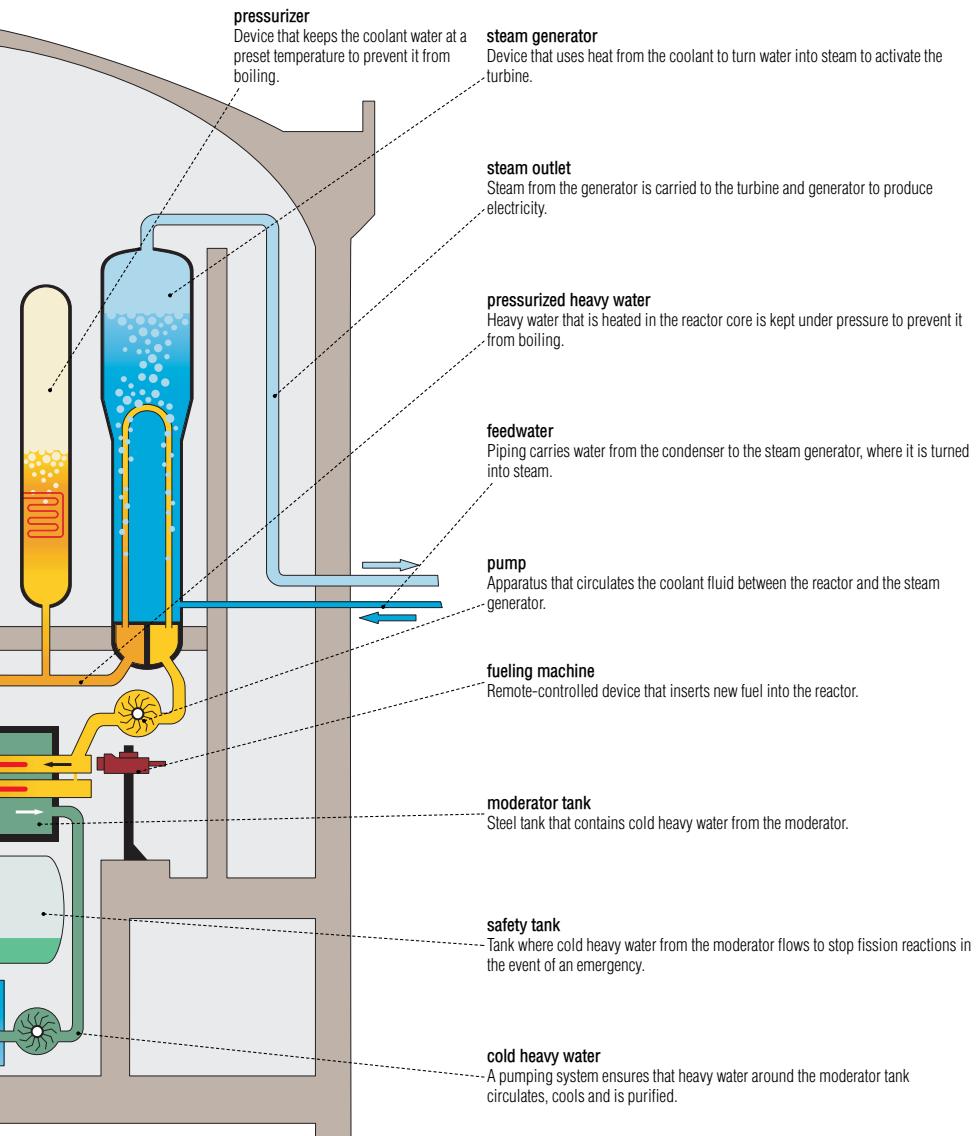
Heavy water is kept at a set pressure to prevent it from boiling.

**concrete shielding**  
Concrete structure that holds back radioactive products in the event of an accident.

**control rod**  
Tube that contains a neutron-absorbing material (boron, cadmium) that is introduced into the reactor core to control its power.

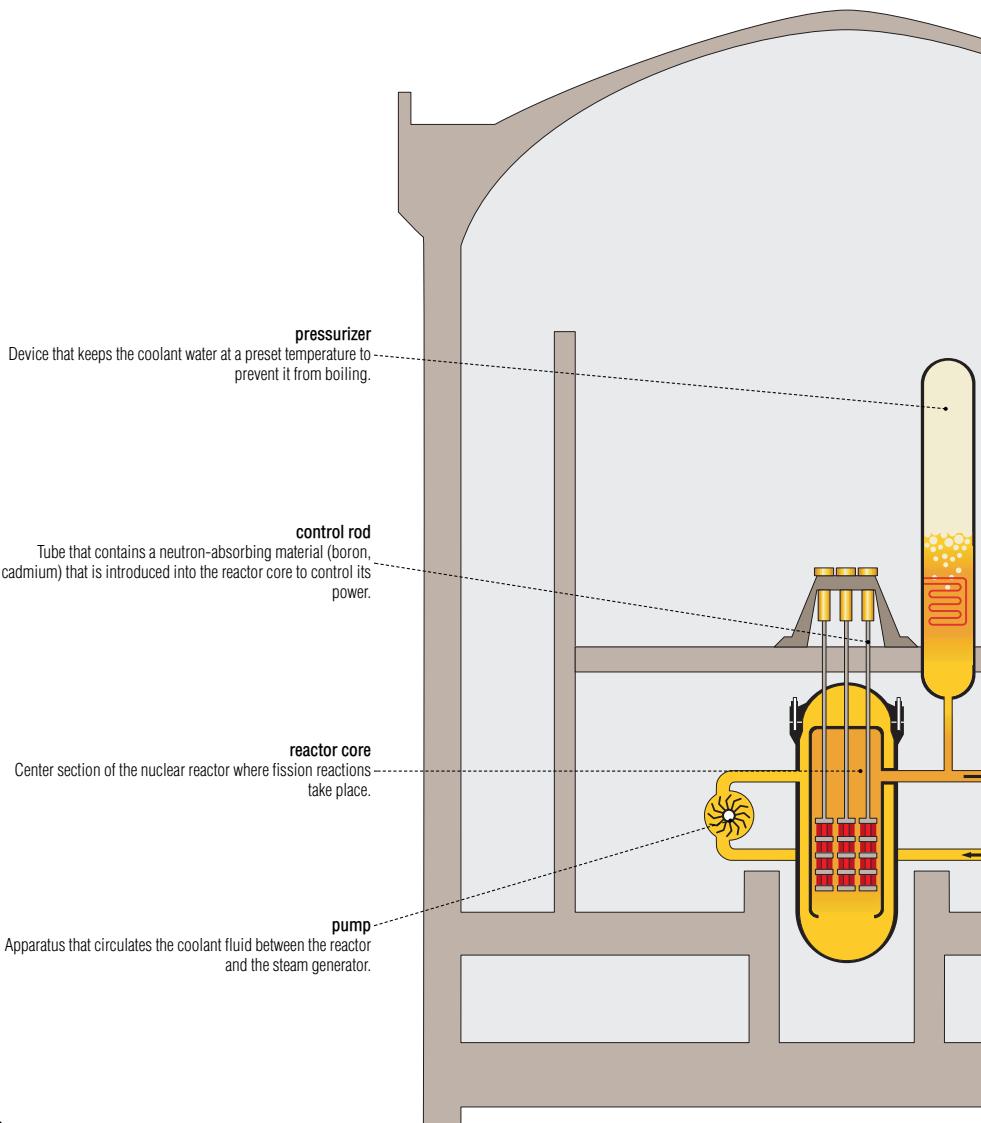
**fuel**  
Matter that is placed in the reactor core; it contains heavy atoms (uranium, plutonium) from which power is extracted by fission.

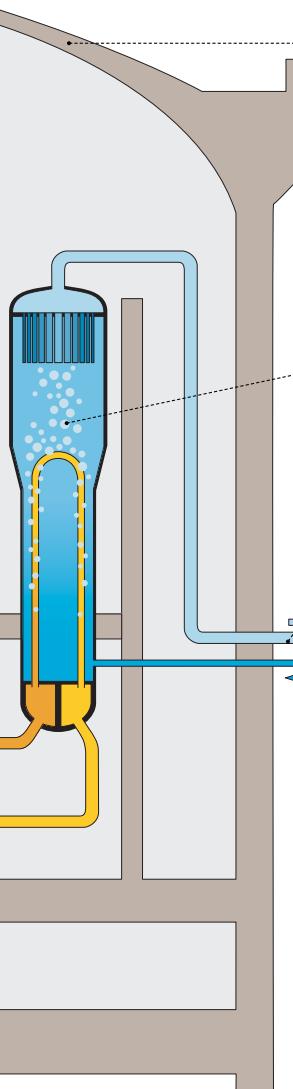




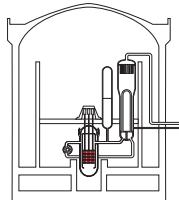
## pressurized-water reactor

The most common type of reactor in the world; water from the coolant is kept under heavy pressure to prevent it from vaporizing.



**concrete shielding**

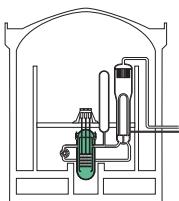
Concrete structure that holds back radioactive products in the event of an accident.

**fuel: enriched uranium**

Enriched uranium: uranium produced by treating natural uranium to increase the quantity of fissionable isotopes (uranium-235) contained in it.

**steam generator**

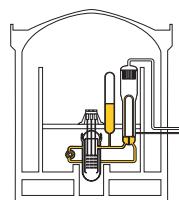
Device that uses heat from the coolant to turn water into steam to activate the turbine.

**moderator: natural water**

Natural water: water found in its natural state.

**steam outlet**

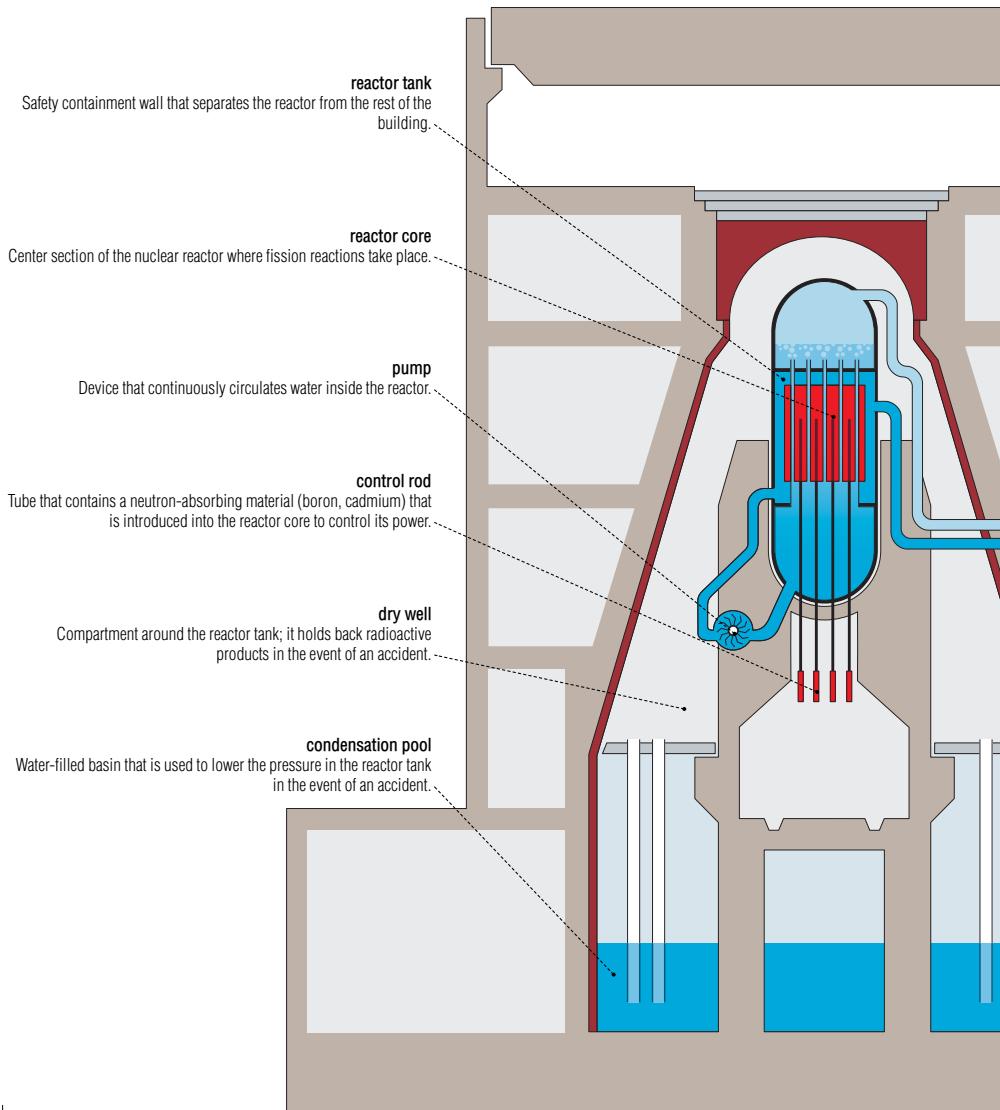
Steam from the generator is carried to the turbine and generator to produce electricity.

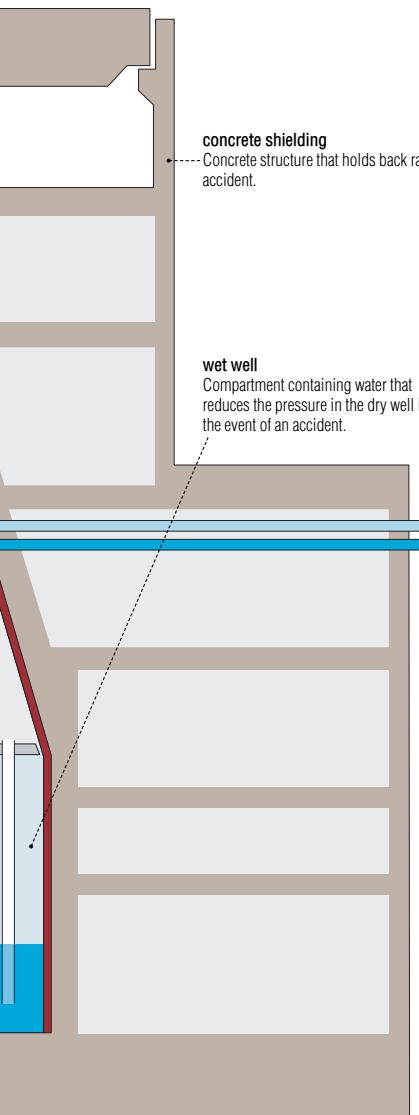
**coolant: pressurized water**

Pressurized water: natural water kept under a preset pressure to prevent it from boiling.

## boiling-water reactor

In this second most common reactor, boiling occurs directly in the reactor core; it is used mainly in the United States, Sweden and Japan.



**concrete shielding**

Concrete structure that holds back radioactive products in the event of an accident.

**wet well**

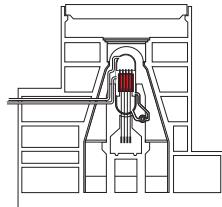
Compartment containing water that reduces the pressure in the dry well in the event of an accident.

**steam outlet**

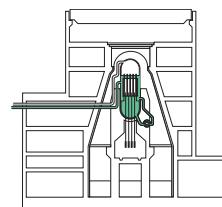
Steam produced in the reactor tank is carried to the turbine to produce electricity.

**feedwater**

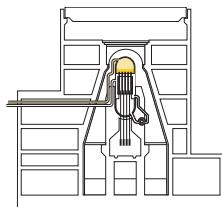
Piping that carries water from the condenser into the reactor tank, where it is converted into steam.

**fuel: enriched uranium**

Enriched uranium: uranium produced by treating natural uranium to increase the quantity of fissionable isotopes (uranium-235) contained in it.

**moderator: natural water**

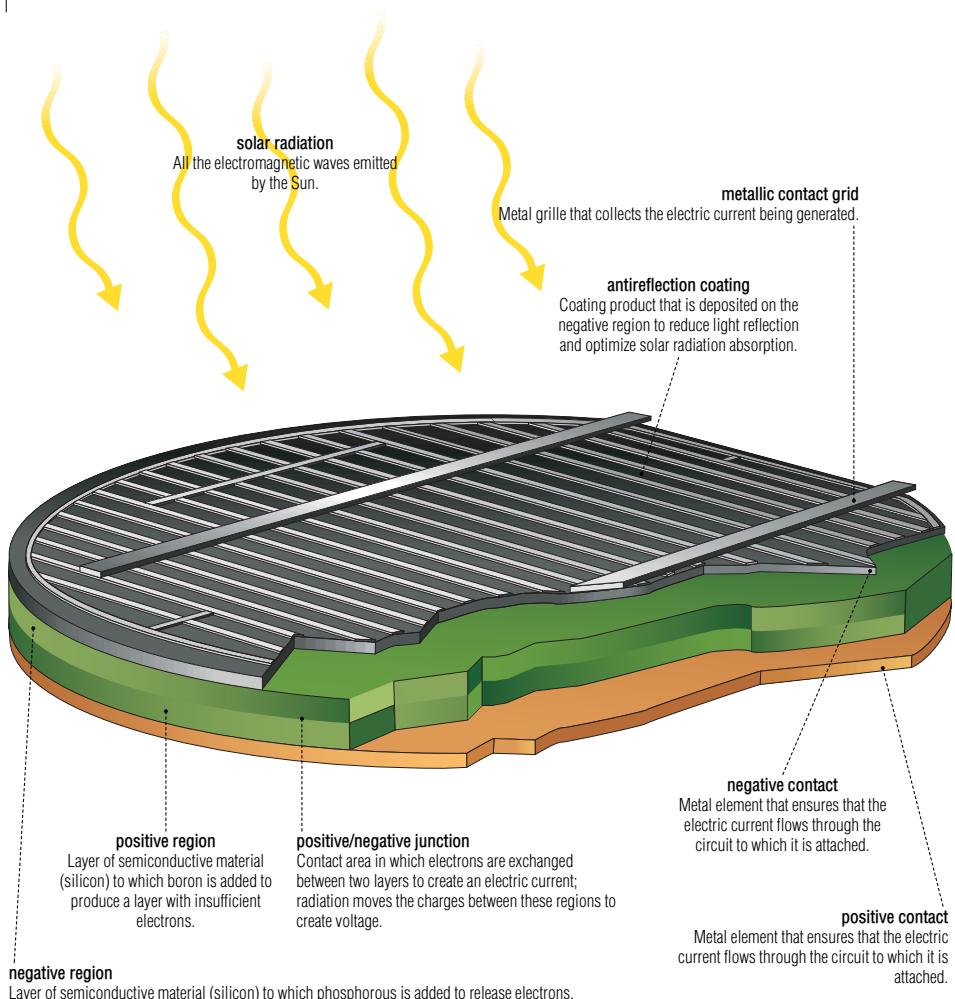
Natural water: water found in its natural state.

**coolant: boiling water**

Boiling water: natural water that boils and vaporizes on contact with the heat released by the fuel.

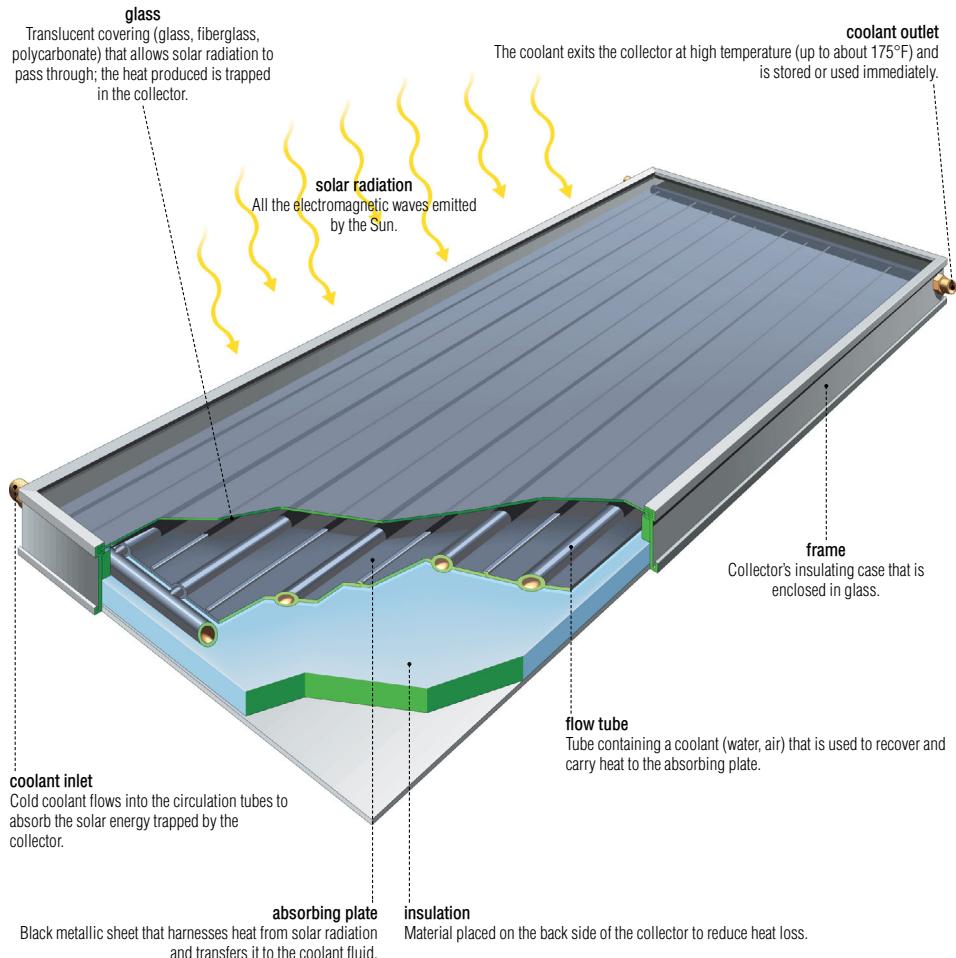
# solar cell

Device used to convert solar energy directly into electric energy (photovoltaic effect).



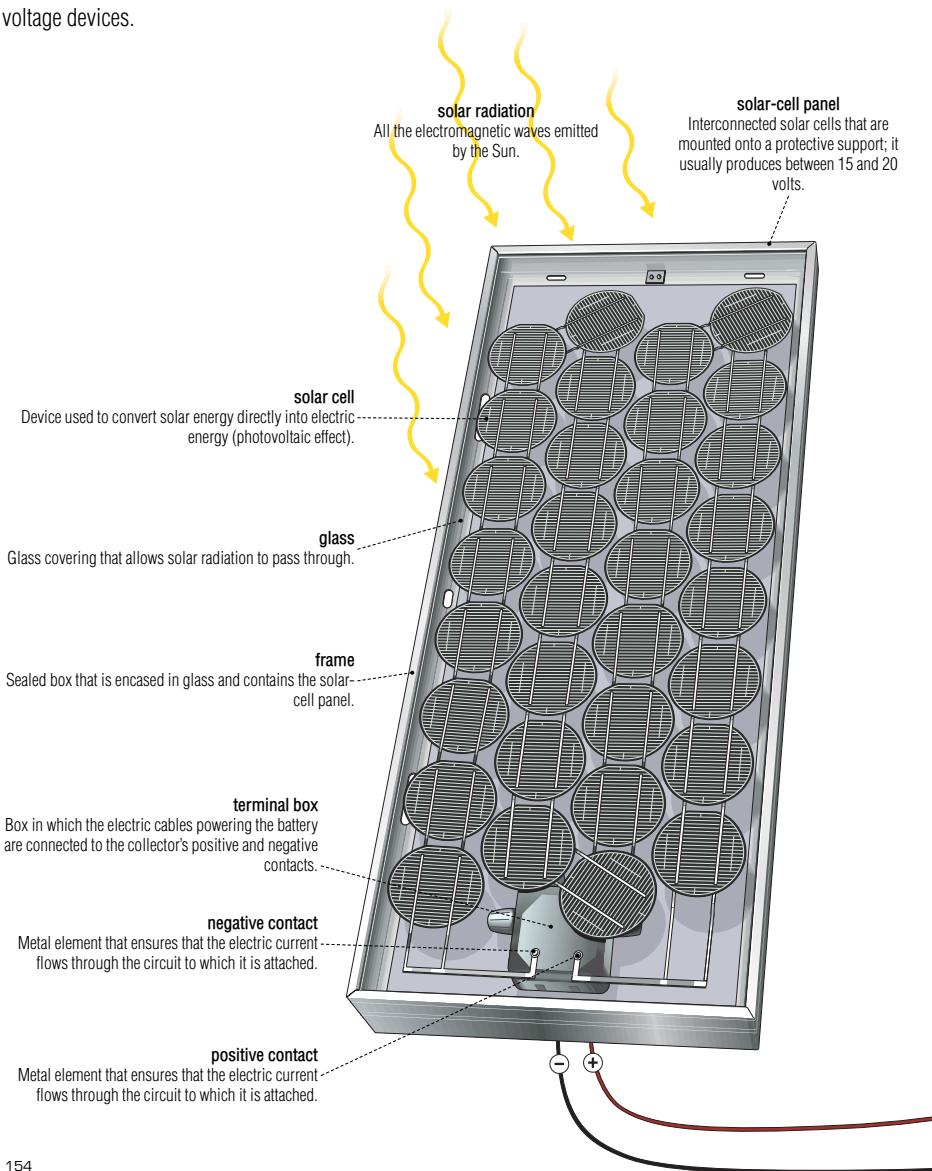
## flat-plate solar collector

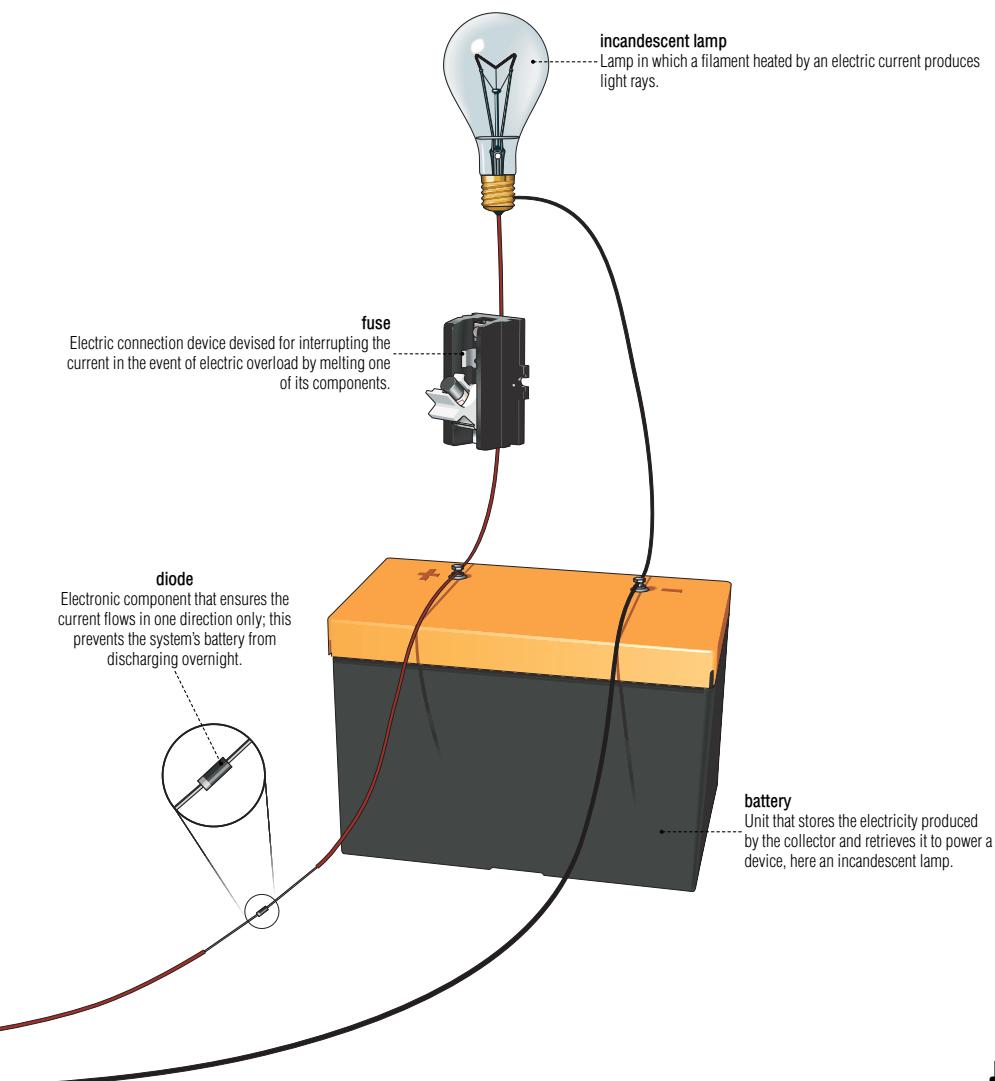
Device that collects solar radiation and heats a coolant, which in turn will be used in residential settings to heat water or the home.



## solar-cell system

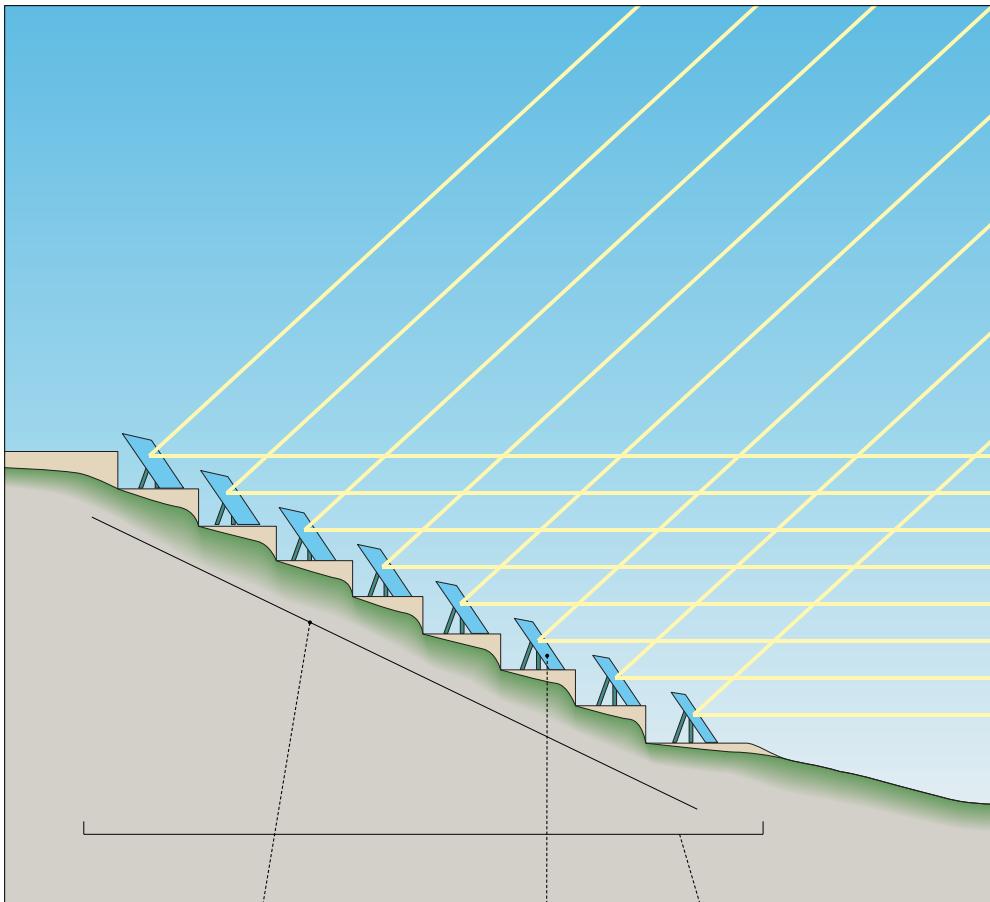
Unit that is usually made up of 36 solar cells, each of which produces a voltage of 0.5 V; it is used to power low-voltage devices.





## solar furnace

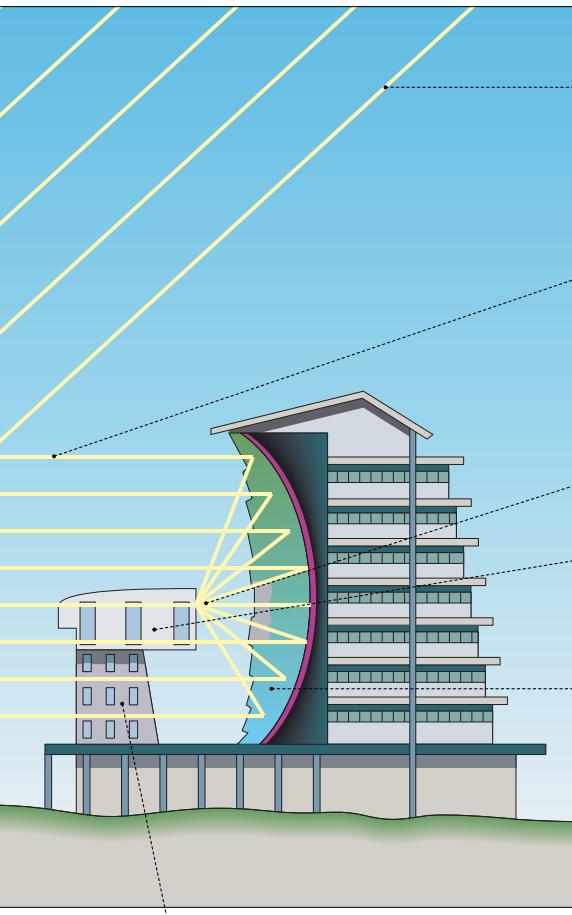
Plant that concentrates solar radiation to reach very high temperatures (over 5,400°F) as part of a research effort to develop experimental materials (including astronautic materials and ceramics).



Heliostats are placed on slopes to prevent energy loss due to shade or the interception of reflected rays by neighboring mirrors.

**reflecting surface**  
Polished metallized glass that receives solar radiation and direct it to the parabolic mirror.

**bank of heliostats**  
Heliostats: remote-controlled adjustable mirrors that follow the Sun's trajectory and concentrate solar radiation toward the boiler at the top of the tower.

**solar radiation**

All the electromagnetic waves emitted by the Sun.

**solar ray reflected**

Solar rays that reach the heliostats are sent to the parabolic mirror.

**target area**

Point where solar rays reflected by the parabolic mirror converge.

**furnace**

Reaching temperatures of over 5,400°F, it is mainly used to process and develop materials.

**parabolic mirror**

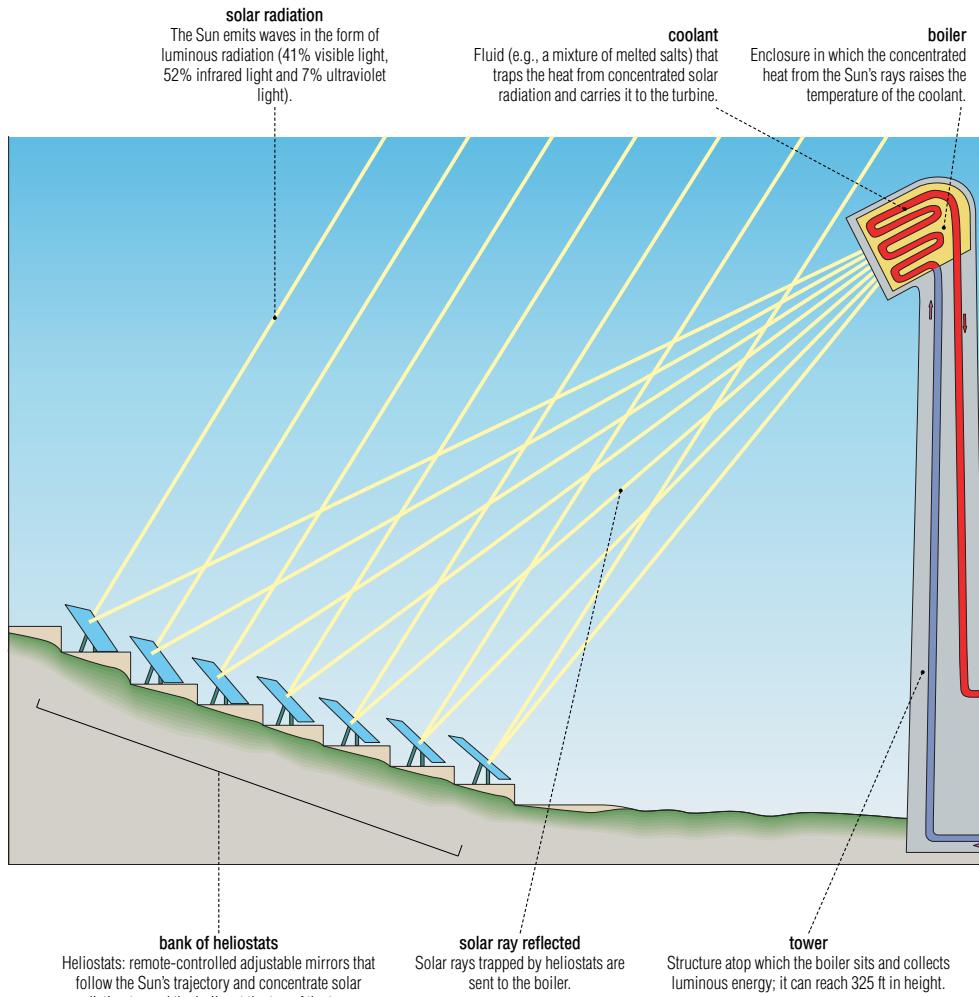
Curved mirror that concentrates the Sun's rays toward one point in the furnace (the target area).

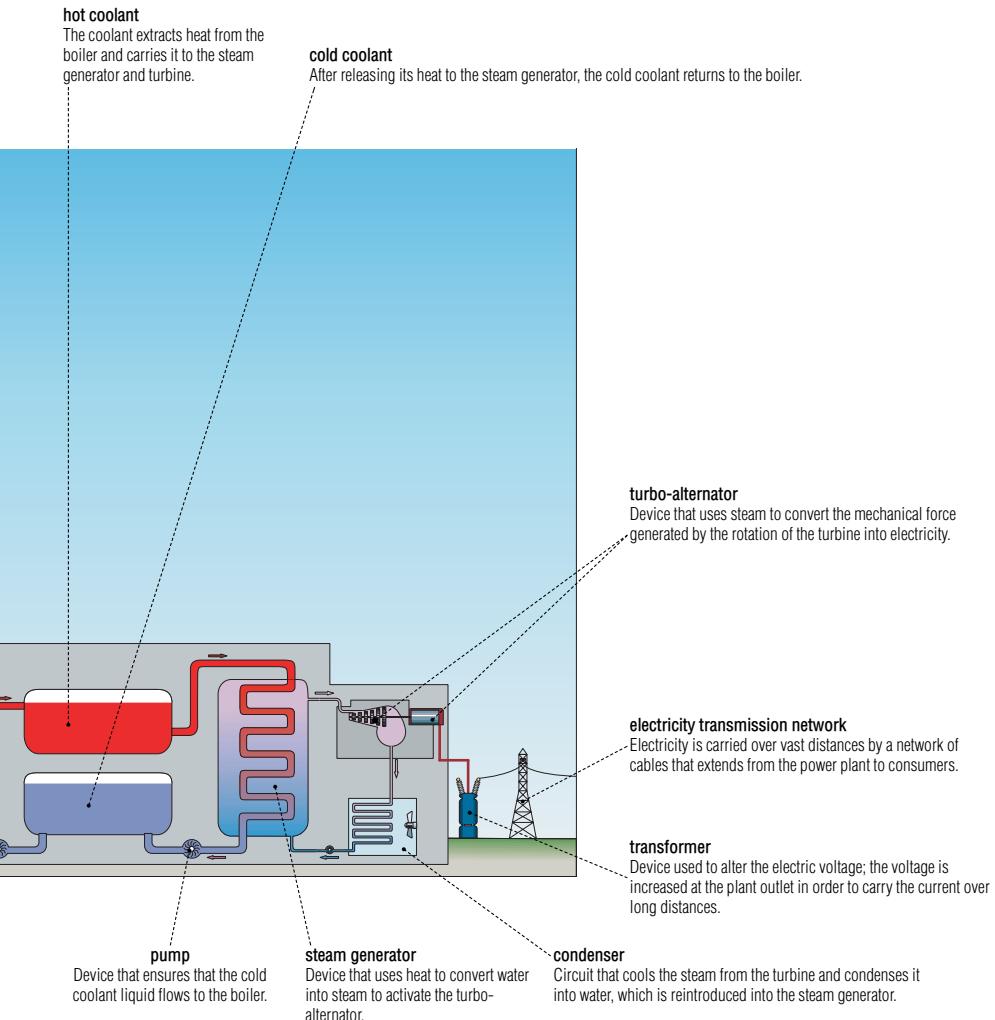
**tower**

Structure atop which the furnace is placed to collect luminous energy; it usually reaches a height of 65 ft.

# production of electricity from solar energy

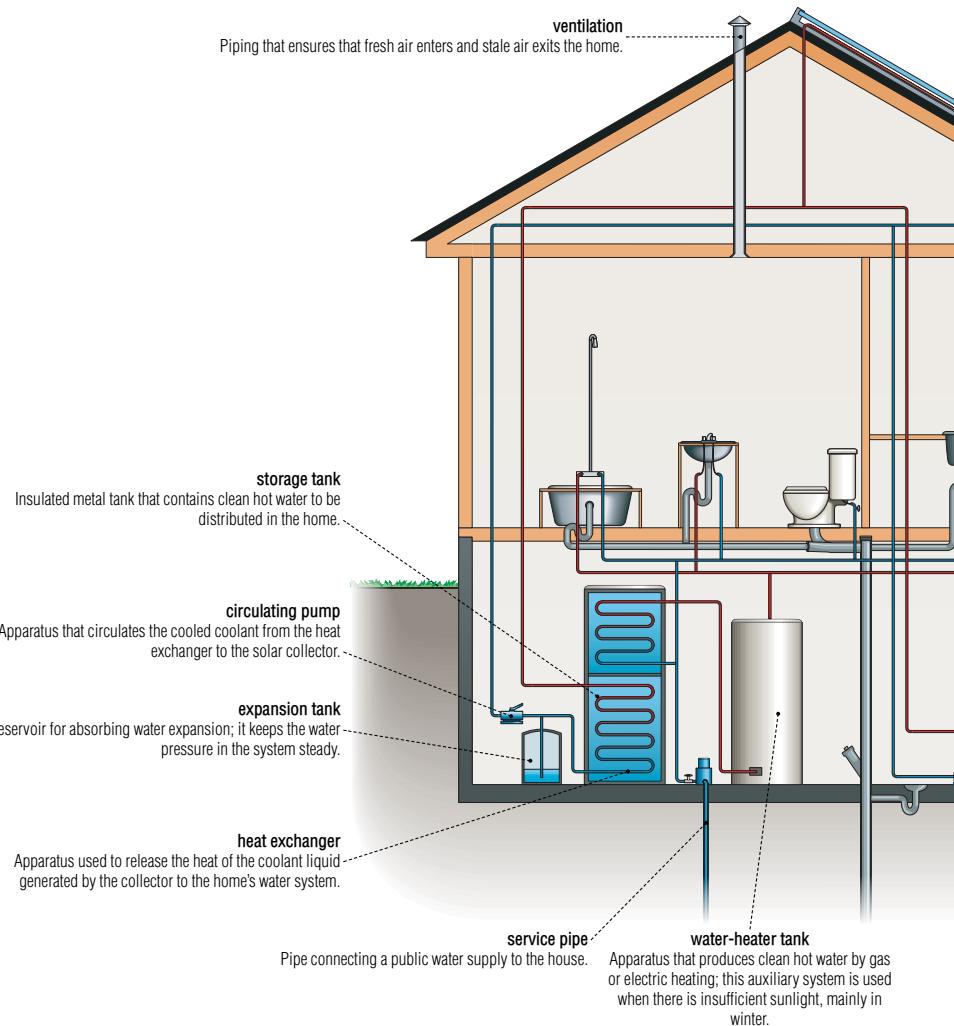
Heating the coolant directly with solar rays turns water into steam, which then turns the turbo-alternator to produce electricity.

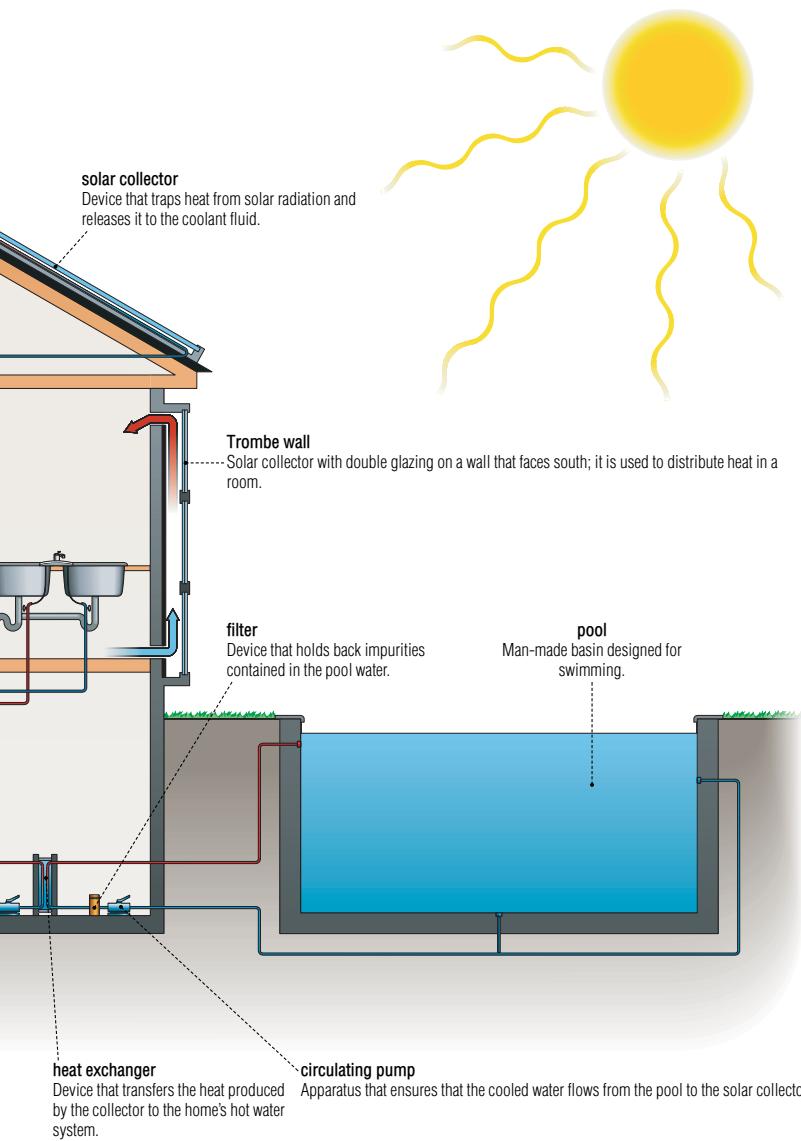




# solar house

Solar energy can be used to heat and supply hot water to a home.





## solar house

**Trombe wall**

Solar collector with double glazing on a wall that faces south; it is used to distribute heat in a room.

**shutter**

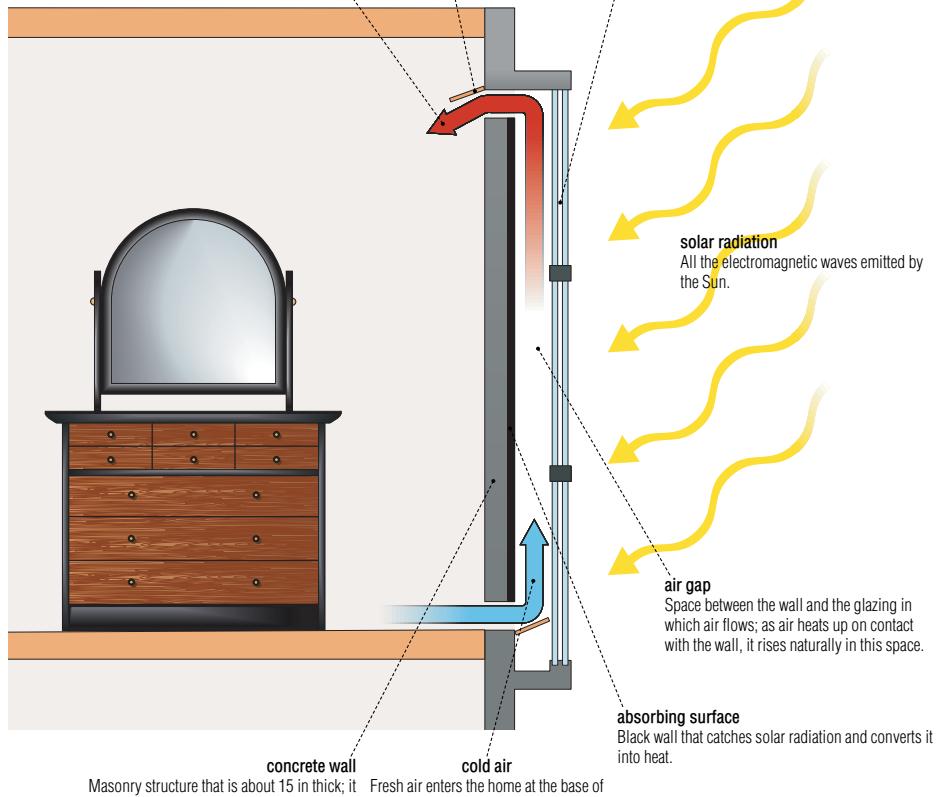
Flap gate used to control the entry of heat into the home.

**warm air**

Air heated by solar radiation is introduced into the room by convection.

**double glazing**

Each of two glass plates placed in front of the concrete wall; they allow solar radiation to penetrate and retain the heat.

**concrete wall**

Masonry structure that is about 15 in thick; it has a black surface to absorb heat from the Sun to heat the air.

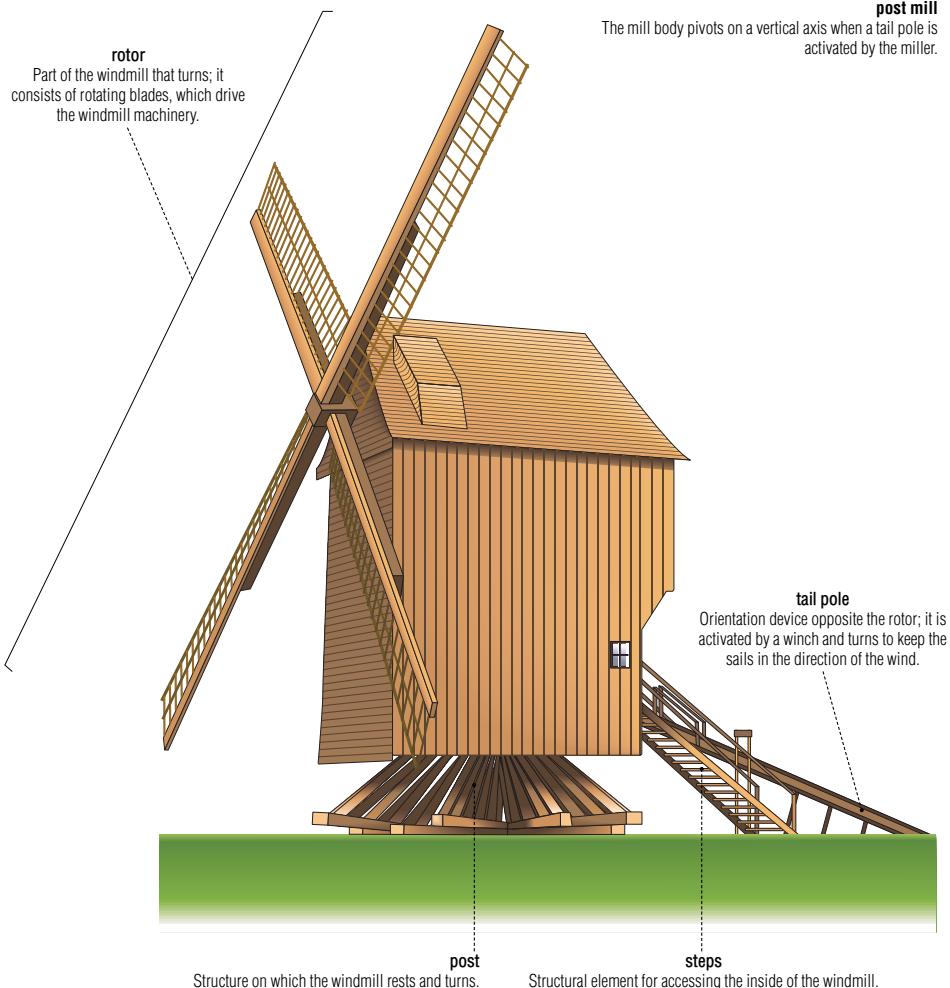
**cold air**

Fresh air enters the home at the base of the air gap and is heated on contact with the wall.

**absorbing surface**

Black wall that catches solar radiation and converts it into heat.

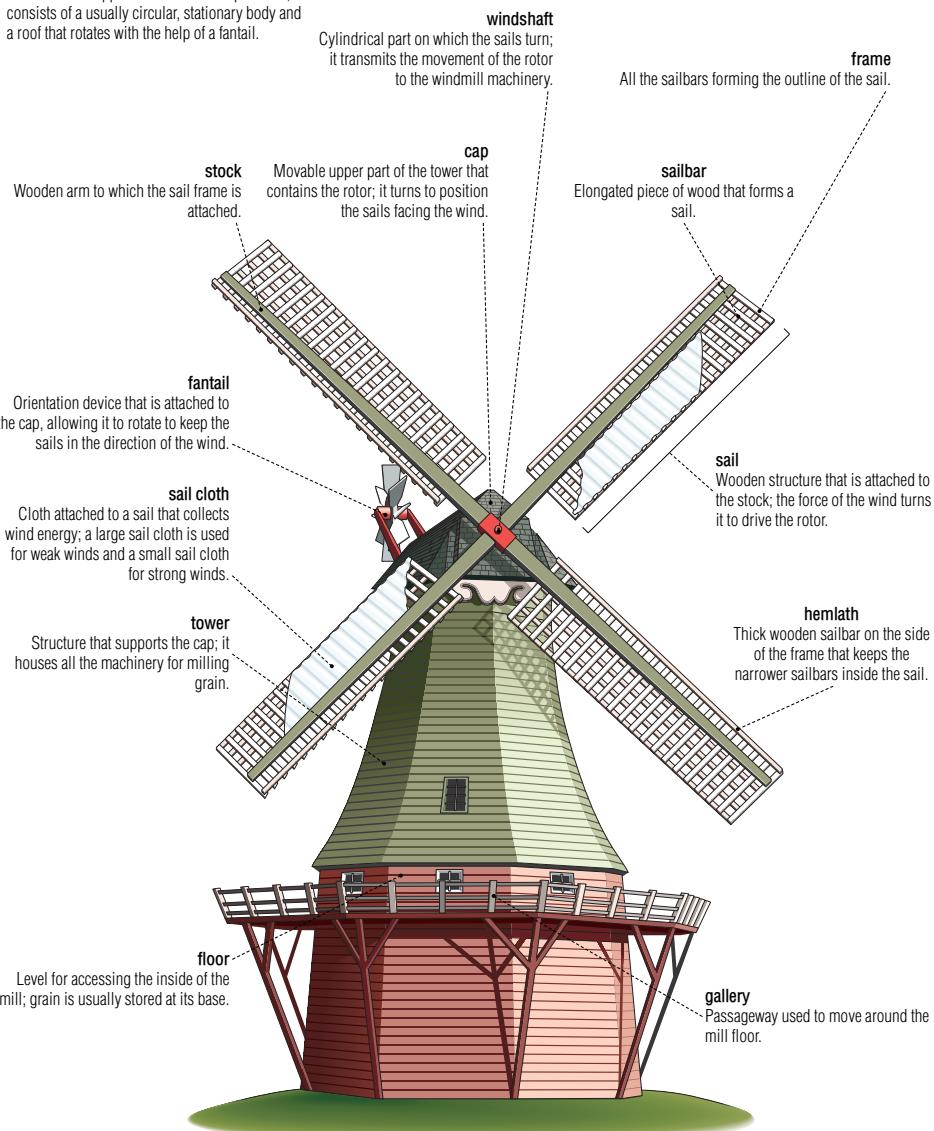
Machine that converts wind energy into mechanical energy; it was used in the past to mill grain and pump water.



## windmill

**tower mill**

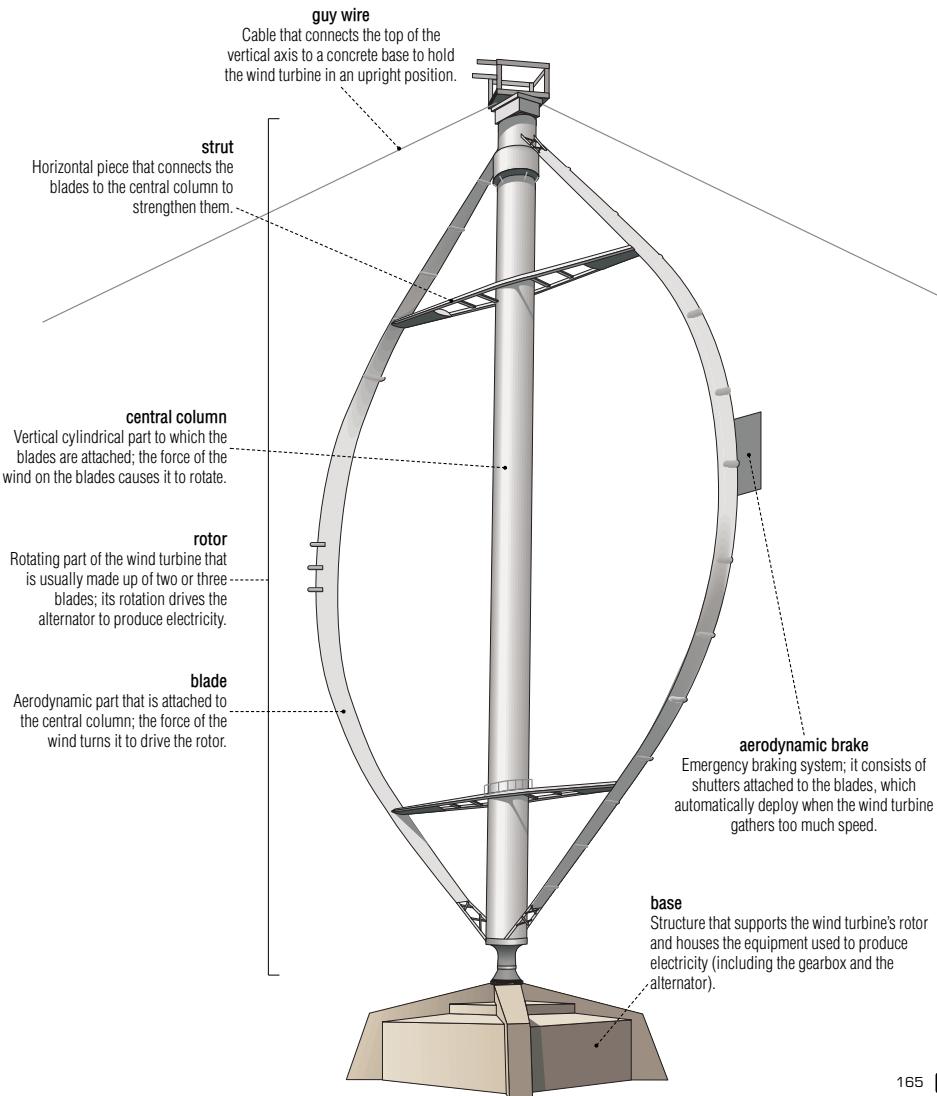
The tower mill appeared later than the post mill; it consists of a usually circular, stationary body and a roof that rotates with the help of a fantail.



Wind turbine: machine that harnesses energy from the wind and converts it into mechanical energy to activate the alternator.

### vertical-axis wind turbine

Wind turbine whose axis is perpendicular to the wind.

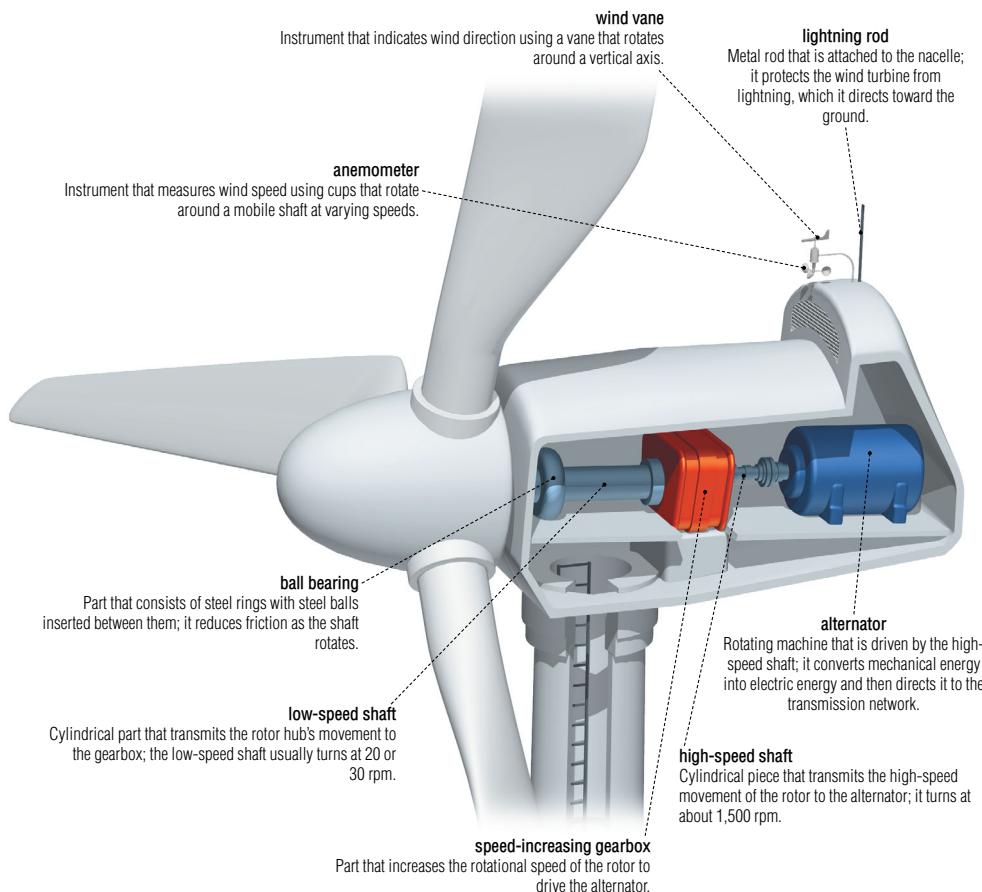


## wind turbines and electricity production

**horizontal-axis wind turbine**

The most common type of wind turbine; its axis positions itself in the direction of the wind.





## wind turbines and electricity production

### production of electricity from wind energy

Wind farms contain a group of wind turbines, which are driven by the wind; they produce electricity and carry it along the transmission and distribution networks to which they are connected.

### horizontal-axis wind turbine

The most common type of wind turbine whose axis is parallel to the direction of the wind.

### energy integration to the transmission network

The electricity produced is integrated into the network.

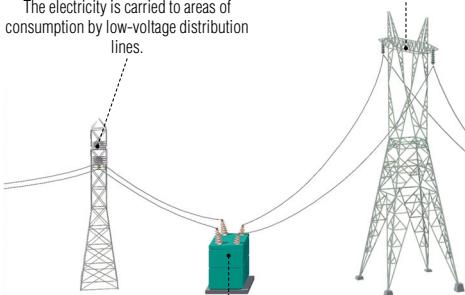


### high-tension electricity transmission

Using high-voltage lines to transmit electricity over long distances reduces the strength of the current and, as a result, energy losses.

### transmission to consumers

The electricity is carried to areas of consumption by low-voltage distribution lines.



### voltage decrease

Before integrating the electricity into the home network, the voltage is progressively decreased to 240 V.

### second voltage increase

### first voltage increase

Increase in voltage: transformers carry high-voltage electricity produced by the alternator to reduce loss during transport.

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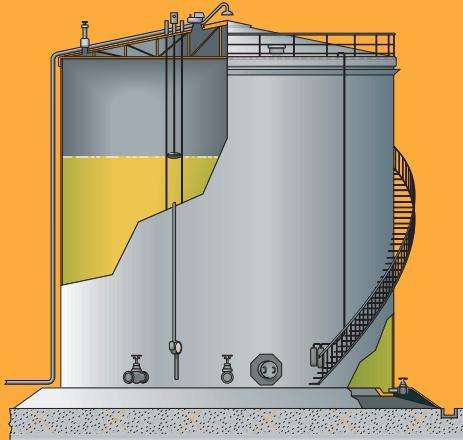
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