The sum of all types of energy in an isolated system is a constant value - this is the law of conservation and transformation of energy, which the ancient Greeks formulated as "nothing comes from nothing." Many scientists have contributed to the discovery of this law. We will talk about some of them here.

For many years there have been disputes in the scientific community as to who was the first to discover the famous Law of Conservation of Energy. In addition to Joule, it was formulated by the German scientist Mayer, who did this a little earlier. However, Mayer was a doctor by profession and his work in physics was not taken seriously, while Joule was known and supported by major luminaries in the field of physics.

The struggle for priority was carried out by a number of English and German scientists, while each of them, as a rule, defended his compatriot and belittled the contribution of the "foreigner". In the end, Mayer's priority was formally recognized, but it would be more correct to say that both scientists came to this law almost simultaneously.
According to Joule's research, the heat that is released in a conductor is proportional to its resistance and the quadratic strength of the current passing through it. The first mention of this relationship by Joule dates back to 1841, however, this statement has a second recognized author - the Russian scientist Lenz, who came to similar conclusions in 1842. Today, the law bears the name of Joule-Lenz.

Emil Khristianovich Lenz (Heinrich Friedrich Emil Lenz) was born on February 12 (24), 1804 in the city of Derpt (Yuriev - now Tartu) in the family of the chief secretary of the city magistrate Christian Heinrich Friedrich Lenz. By origin, he was a Baltic German. Mother Louise, as mentioned earlier, ran the house. His father died when Emily was 13 years old. The family was left almost without a livelihood. The widow raised Emilia and his younger brother Robert with difficulty. The uncle, Professor of Chemistry F. I. Giese, provided all possible financial support to the Lenz family.

Louise was able to enroll the children in Dittler's private school. Here Aemilius showed excellent abilities in mathematics and natural sciences. He graduated from the gymnasium as the first student.

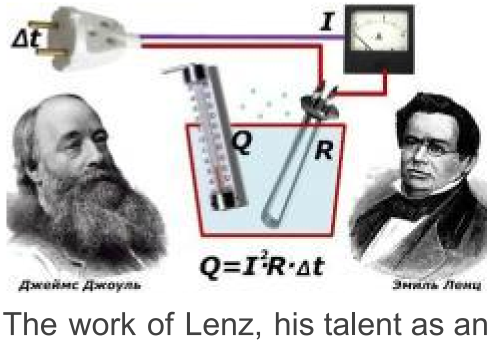
In 1820, on the advice of his uncle, F.I. Giese, 16-year-old Emilius entered Dorpat University, where he studied physics and physical geography under the guidance of Professor G. Peiper. In 1821, Professor F.I. Giese, who provided significant assistance to the Lenz family, died. Having lost his uncle's support, Emilius was forced to move to the theological faculty, which gave him some material support. Feeling, however, no inclination towards theology, Aemilius continued to study physics.

Even before the end of the university course, E.X. Lenz, thanks to his outstanding abilities, on the recommendation of university professors, was invited to participate as a physicist in Otto von Kotzebue's circumnavigation of the world on the sloop "Enterprise".

Even at the stage of preparation for swimming, the scientist created several instruments that helped in the study of the ocean. Among them, a bathometer is a device for taking water samples from great depths. At the end of the 19th century, Admiral Stepan Osipovich Makarov spoke highly of the physicist's invention, calling it the best way to deliver water from the depths.

The expedition left Kronstadt at the end of July 1823. Rounding Cape Horn in January 1824, the "Enterprise" headed for the Tuamotu archipelago. In March 1824, the sloop anchored off the island of Tahiti, from where it moved to the shores of Kamchatka. After a short stay in Petropavlovsk, the ship headed for Alaska, from where it proceeded to San Francisco, and then to the Hawaiian Islands. From the islands, the "Enterprise" again headed north to Alaska, then headed for the Marshall Islands. Having made an inventory of several groups of atoll islands, the sloop returned to Russia in July 1826 through Manila and the Sunda Strait. Throughout the expedition, E. Kh. Lenz, together with other members of the crew, studied air and sea currents, the composition and properties of sea water; conducted astronomical and geographical observations, made an accurate inventory of the coasts (including Eastern Kamchatka), studied the relief, geological structure, features of inland waters and soils.

Before the research of E. Leitz, winds were considered the only cause of sea currents. Lenz found that the cause of a number of sea currents is the difference in water density at high and low latitudes. Such are the deep currents of cold waters from the regions adjacent to Antarctica and from the Arctic Ocean. This also explains the low water temperatures in the deep layers of the tropical zone of the World Ocean.



The work of Lenz, his talent as an inventor was highly appreciated. He published the results of scientific research of this expedition in 1831 in the Memoirs of the Academy of Sciences.

In a very short time, together with the rector E. I. Parrot, he created unique instruments for deep-sea oceanographic observations - a winch-depth gauge and a bathometer. On the voyage, Lenz made oceanographic, meteorological, and geophysical observations in the Atlantic, Pacific, and Indian oceans.

A remarkable feature of Lenz as a scientist was a deep understanding of physical processes and the ability to discover their patterns.

Upon returning from the expedition, E. Kh. Lenz left the university and lived for some time with his mother in Dorpat. Then he moved to Petersburg. A year later, the scientist brilliantly defended his doctoral dissertation in Heidelberg on the results of his recent oceanological research.

In 1828, for the outstanding results of geophysical research (the work "On the salinity of sea water and its temperature in the oceans on the surface and in depth"), carried out during the expedition, Emil Khristianovich was elected an adjunct of the St. Petersburg Academy of Sciences in the Department of Physics, and in 1834 - - Academician of the St. Petersburg Academy of Sciences. From that time on, his interests moved to the field of electricity.

In September 1829, Lenz carried out gravitational and magnetic observations at the Nikolaev Observatory according to the program compiled by A. Humboldt, participating in observations of the swing of the pendulum at this point on the globe.

The expedition to the Crimea and the Caucasus was also successful, where he also took part in the first ascent of Elbrus and determined the height of this mountain by barometric method. The height of the ascent was 4267 meters, the weather did not allow reaching the top, although only 183 meters remained before it. On the map of Elbrus, to the northeast of the summit, the Lenz Rocks remained.

In the same way, he established that the level of the Caspian Sea is 30.5 meters lower than the Black Sea. Lenz invented the magnetic theodolite and improved a number of other geophysical instruments.

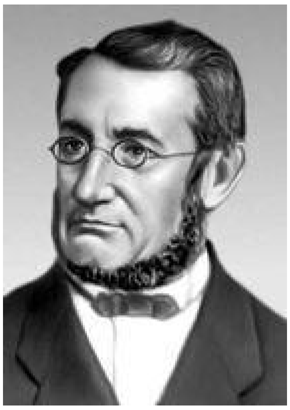
Lenz laid the foundations for the ballistic method of measuring physical quantities and contributed to the recognition of Ohm's law. Using the results of Lenz, G. Helmholtz obtained an expression for the EMF of induction based on the law of conservation and transformation of energy.

In 1833, Lenz noticed that Faraday's and Nobili's rules for determining the direction of inductive currents provided for too many different cases, while, given Ampère's electrodynamic law, they could easily be reduced to one rule applicable in all cases. Lenz formulated this rule, which now bears his name (Lenz's law). Lenz's rule revealed the main regularity of the phenomenon: the induced current always has such a direction that its magnetic field counteracts the processes that cause induction.

Although Lenz did not formulate the law of conservation of energy, the energy approach can be traced in his works.

In 1836, Lenz headed the Department of Physics and Physical Geography at St. Petersburg University, and from 1840 he was dean of the Faculty of Physics and Mathematics.

In 1839, he compiled a "Guide to Physics" for Russian gymnasiums, which went through eleven editions.



In 1840, E. H. Lenz was awarded a doctorate from the University of Helsingfors. Among his students were D.I. Mendeleev, K.A. Timiryazev, P.P. Semyonov-Tyan-Shansky, F.F. Petrushevsky, A.S. Saveliev and others.

In 1842, studying the thermal effect of current, Lenz discovered, independently of James Joule, the law, which now bears the name of Joule-Lenz, according to which the amount of heat released during the passage of an electric current is directly proportional to the square of the current, the resistance of the conductor and time.

Together with B.S. Jacobi Lenz developed methods for calculating electromagnets in electrical machines, established the existence of the "armature reaction" in the latter. He studied the dependence of the resistance of metals on temperature.

In 1845, the Russian Geographical Society was established. Academicians E. Lenz, F. Struve, E. Baer, Admirals A. Kruzenshtern, F. Wrangel and writer V. Dahl were among its founders. Until the end of his life, Emilius Khristianovich did a lot of versatile work in the Geographical Society.

In 1851, the fundamental work of Emil Lenz "Physical Geography" was published, which was later repeatedly reprinted in Russia and abroad. In this work, Lenz examined the structure of the earth's crust, the origin and movement of the rocks that form it, and showed that it is constantly changing and that this process affects the topography of the continents. He discovered important regularities in the daily and annual variations in air temperature and pressure, wind activity, water evaporation, water vapor condensation and cloud formation, electrical and optical phenomena in the atmosphere: he explained the origin of the blue color of the sky, rainbows, circles around the Sun and Moon, and a number of rare atmospheric phenomena. phenomena.

Lenz established the reason for the slight increase in water temperature with depth in the zone south of 51 degrees south latitude and noted that a similar reversal of this characteristic should take place in the Arctic Ocean. Lenz found that the salinity of water changes little with depth, while in the upper layer it decreases with latitude.

The density of water increases with latitude and with depth. The main reason for this change is the decrease in water temperature in these directions.

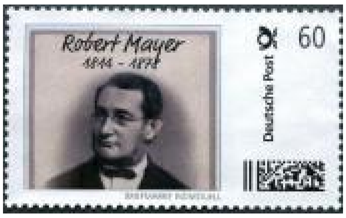
Lenz came to the conclusion that due to the increase in the density of water with latitude in the World Ocean, along with the currents caused by the wind and the slope of the level, there must be a general and no less strong movement of surface water from the tropical zone to high latitudes and the movement of deep water from these areas in the tropics.

Of great importance for the development of Earth science is Lenz's position, according to which the main cause of the processes occurring in the atmosphere is solar radiation. Lenz concluded that the largest part of solar radiation is absorbed by the oceans. This energy is spent mainly on the evaporation of water, causing its circulation in the epigeosphere. Therefore, the oceans, huge reservoirs of heat and moisture, play a gigantic role in shaping the Earth's climate. Along with the American scientist M.F. Mori, he was the founder of the doctrine of the interaction of the ocean with the atmosphere.

Continuing persistently to engage in physical research, E. Kh. Lenz taught physics and physical geography for more than 30 years at various military and civilian higher educational institutions in St. Petersburg. He taught at the Naval Corps, at the Mikhailovsky Artillery Academy, at the Pedagogical Institute, and also lectured on physics to Grand Dukes Konstantin, Nikolai and Mikhail Nikolaevich and Grand Duchesses Olga and Alexandra Nikolaevna. In those days, the custom was widespread to give lectures on some foreign textbook with minor additions, which was so directly announced in the curriculum. E. Lenz gave lectures "according to his own notes", they were distinguished by a strict presentation and were always accompanied by demonstrations of experiments for which he had prepared in advance. Since 1863 he was the rector of St. Petersburg University.

The main results of his research are presented in all physics textbooks. Exactly:

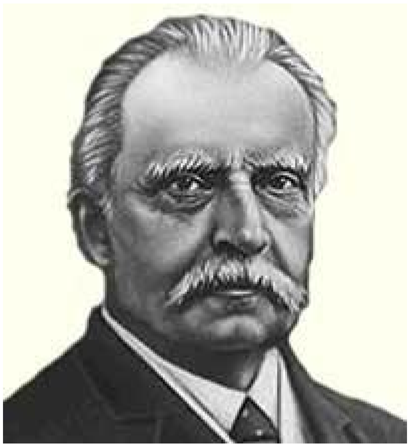
- the law of induction ("Lenz's Rule"), according to which the direction of the induction current is always such that it prevents the action (eg movement) by which it is caused (1834).



- "Joule and Lenz's Law": the amount of heat generated by the current in the conductor is proportional to the square of the current strength and the resistance of the conductor (1842).

- Experiments confirming the "Peltier phenomenon"; if a galvanic current is passed through bismuth and antimony rods, soldered at the ends and cooled to 0 ° C, then it is possible to freeze water poured into a hole near the junction (1838).

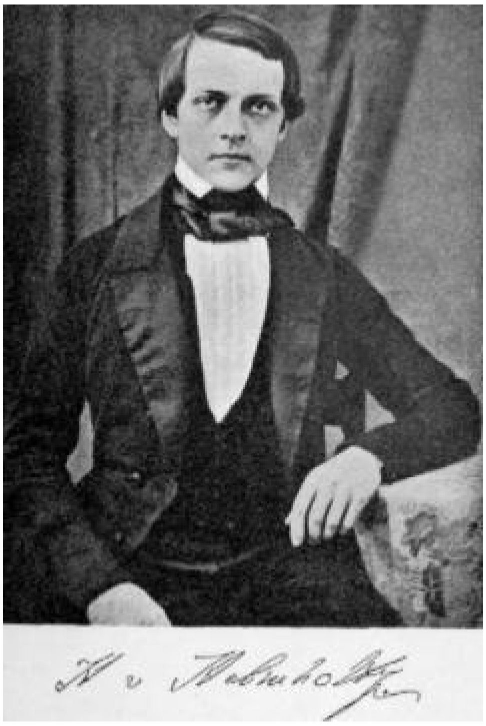
- Experiments on the polarization of electrodes (1847), etc.



A severe eye disease forced E. Kh. Lenz in August 1864 to interrupt his scientific and pedagogical activities and leave for treatment in Rome. Here his condition improved thanks to the efforts of doctors, climate change, and most importantly - rest. He began to see, began to read a little, and even tried to work. However, the improvement was short-lived - on January 29 (February 10), 1865, Emilius Khristianovich died suddenly of a cerebral hemorrhage and was buried in Rome in one of the Protestant cemeteries.

Lenz's discoveries are one of the cornerstones of the modern theory of electromagnetic phenomena and practical electrical engineering.

E. Kh. Lenz is known for many discoveries in the field of physics. But among his scientific works, two are especially famous. In 1833, he established a rule for determining the direction of the electromotive force of induction (the so-called Lenz law), and in 1842 (independently of J. Joule) - the law of the thermal effect of electric current (known as the Joule-Lenz law). In addition, together with B.S. Yakobi, Emily Khristianovich was the first to develop methods for calculating electromagnets in electrical machines.

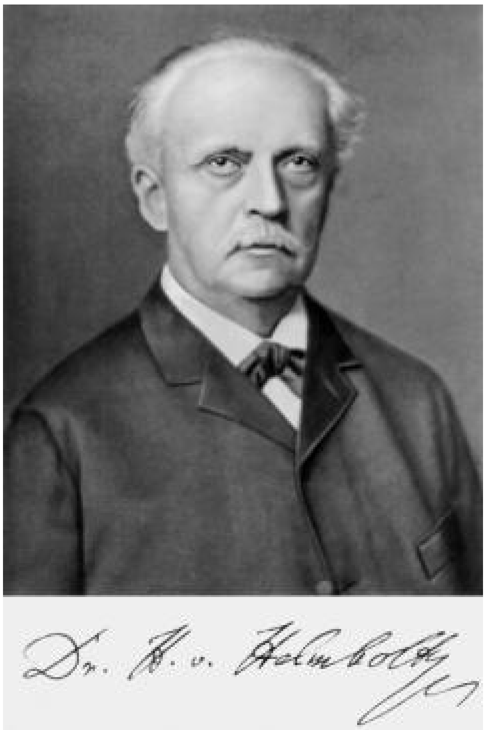


In 1970, the International Astronomical Union named a crater on the far side of the Moon after Emil Khristianovich Lenz.

But let us return to the law of conservation and transformation of energy.

Julius Robert von Mayer was born on November 25, 1814 in Heilbronn (Germany) in the family of a pharmacist. Possessing poor health, he was able to finish high school only at the age of twenty-one. After school, following the example of his father, Meyer began to study medicine. He received his higher medical education at the University of Tübingen, from which he graduated in 1838 with a doctorate in medicine. After several months of work in clinics in Paris, Mayer set sail as a ship's doctor on a Dutch ship to the island of Java. The voyage lasted a year (1840–1841). It was at this time that the first observations were made that led Mayer to the discovery of the law of conservation of energy.

Providing medical assistance to a sick sailor, Mayer noted that "the blood emitted from a hand vein was distinguished by such an unusual redness that, judging by the color, I might think that I had hit an artery." From this he concluded that "the temperature difference between the body's own heat and the heat of the environment should be in quantitative proportion with the difference in the color of both types of blood, that is, arterial and venous...".



Mayer came to the most important conclusion that the body is governed by natural physical and chemical laws and, above all, by the law of conservation and transformation of energy. Returning from a trip, he wrote an article "On the quantitative and qualitative determination of forces" (Meyer designates energy by the term "force"), which he sent on June 16, 1841 to the journal "Annals of Physics".

However, the editors did not publish the article of the novice researcher and did not even answer him. The article, containing the idea of a great discovery, lay in the editor's desk for 36 years.

Without waiting for an answer, Mayer writes a second article entitled "Remarks on the Forces of Inanimate Nature", which appeared in May 1842 in the journal "Annals of Chemistry and Pharmacy". However, physicists did not read this journal, and this played a tragic role in Mayer's creative life. The article raises the problem of experimental determination of the mechanical equivalent of heat and proposes the idea of such an experiment (it was set up in 1847 by Joule, who did not know about Mayer's work.) This work by Mayer is rightfully considered fundamental in the history of the law of conservation and transformation of energy.

From his result, he drew the correct conclusion about the imperfection of steam engines. Mayer writes: “If we compare the useful action of our best steam engines with this result, we will see that only a very small part of the heat dissipated under the boiler is actually converted into movement or lifting of a load ...”

Of particular importance is Mayer's idea of the qualitative transformation of types of energy with their quantitative conservation. He analyzes this problem in detail in his third work, the pamphlet Organic Movement in its Connection with Metabolism, which he published at his own expense in 1845.

Mayer's discovery remained unknown to physicists, and the conservation law was discovered independently by other scientists - the Englishman Joule and the German Helmholtz. Meyer found himself embroiled in a dispute over priority that weighed heavily on him.

In his writings, Mayer lists various types of energy: the kinetic energy of moving masses, the potential energy of a lifted load, internal, electrical and magnetic (it should be noted Mayer's brilliant intuition, who realized that electromagnetic phenomena also obey the law of conservation of energy).

Mayer concludes his analysis with chemical energy. Mayer revealed the cosmic role of plants and put forward the problem of photosynthesis before science. The lines of his book, devoted to the analysis of solar energy transformations in living organisms, inspired the outstanding Russian scientist K. A. Timiryazev, and he prefaced his book "The Sun, Life and Chlorophyll" with an epigraph from Mayer's pamphlet.

In his 1851 work "Remarks on the Mechanical Equivalent of Heat," Mayer succinctly and popularly expounds his ideas on the conservation and transformation of force, and for the first time makes an attempt to defend his priority in the discovery of the law of conservation of energy. The calm and dignified tone of his statements masks a deep emotional trauma. According to one of the scientists, "... this work was written with Mayer's blood, having exhausted his last strength."

The "co-authors" of the discovery of the law of conservation of energy - Joule and Helmholtz behaved differently. Joule did not support his colleague, believing that it was he, Joule, who first discovered this law by experiment. Helmholtz, to his credit, spoke in favor of Mayer, declaring that the glory of the discovery belongs to the one who first proposed a new idea, even if he could not confirm it with a quantitative experiment.

On the whole, however, the German scientific community did not support Mayer. He was harassed and ridiculed; his family considered him a maniac. In 1850, in a fit of desperation, he tried to commit suicide by throwing himself out of the window of his house, and as a result he remained lame for life. Only gradually, after the recognition of the work by Joule and Helmholtz, Mayer's work begins to receive recognition.

In the autumn of 1851, Mayer fell ill with brain inflammation, after which he was placed first in a private lunatic asylum, and then in a state-run psychiatric hospital with a terrible regime ... I must say that Mayer himself did not consider himself mentally ill. There is other evidence that relatives forcibly sent him to an insane asylum, from which he was released in 1853.

Y. Mayer was declared crazy by English and German physicists, and later completely forgotten. A biographical guide for 1863 reported that he had already died, although he lived until 1878 and in the last years of his life waited for fame. He was awarded the Poncelet Prize (1869), he was awarded the Copley Medal (1871). In 1882, the Royal Society of London awarded the Davy Gold Medal jointly to Mendeleev and Meyer with the wording "For the discovery of periodic relations of atomic weights." In foreign literature, L. Meyer is usually regarded as one of the authors of the periodic system of chemical elements.

In 1867 Mayer married his colleague, Johanna Volkmann. The marriage produced four children, who also chose a scientific career.

Mayer died on March 20, 1878. Shortly before his death, in 1874, a collection of his works on the law of conservation and transformation of energy was published under the title "Heat Mechanics". In 1876, his last works “On the Torricelli emptiness” and “On the liberation of forces” were published.

The assessment of Mayer's merits in the creation of the mechanical theory of heat caused at one time a fierce controversy between Clausius, Tyndall, Joule, and Dühring.

золотая медаль, Германия, 1905 г.

Regardless of Mayer, the law of conservation of energy was developed by G. Helmholtz from a theoretical standpoint.

Hermann Helmholtz (Hermann Ludwig Ferdinand von Helmholtz) was born on August 31, 1821 in Potsdam, near Berlin, where his father Ferdinand Helmholtz served as a gymnasium teacher; his mother Carolina, nee Penn, came from an English family who had settled in Germany. Herman had a bad memory, studied very mediocrely and graduated from the gymnasium with sin in half. During his studies at the gymnasium, no one could even think that he would do so much useful work in science! However, Herman became an outstanding physiologist.

Since childhood, he showed great interest in natural science, he wanted to study physics. But, having graduated from the Potsdam Gymnasium in 1838, at the insistence of his father, he entered the Friedrich Wilhelm Medical Institute in Berlin. The seventeen-year-old student studied physics, chemistry and anatomy in the first semester and in the first year he listened to logic, history, Latin and French. Herman was lucky not only with his fellow students (he studied with a whole galaxy of future luminaries of physiology, who made up the color of German science: Karl Ludwig, Dubois-Reymond, Brucke, Virchow, Schwann), but also with the physiology teacher Johannes Müller, the luminary of German physiological science. In the second semester, under the influence of his famous teacher, Herman became interested in physiology and histology. Müller's students were united by the same desire to connect physics with physiology and find a stronger foundation for their justification. Herman significantly surpassed his friends in knowledge of mathematics, which gave him the opportunity to accurately "formulate problems and give the right direction by the method of solving them."

After graduating from the university in 1842, he defended his doctoral dissertation on the structure of the nervous system. In this work, the twenty-two-year-old doctor proved for the first time the existence of integral structural elements of the nervous tissue, later called neurons.

Already in his student years, he showed an interest in physiology, wondering about the essence of force. In his work "On the Conservation of Force" (1847), he analyzes various phenomena based on the principle of conservation: the fall of bodies, the transition of mechanical motion to thermal motion, the release of heat during chemical reactions, the contact potential difference, and the operation of galvanic cells.

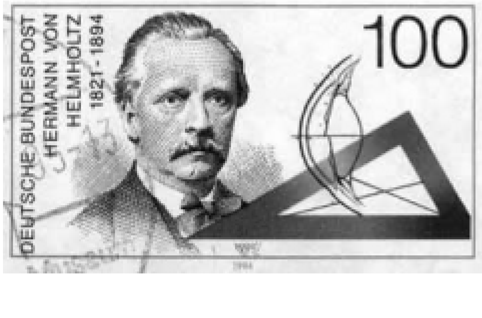
Mandatory for graduates of the Royal Medical and Surgical Institute was an eight-year military service, which Helmholtz had been doing since 1843 in Potsdam, as a military doctor.

He lived in the barracks and got up at five o'clock in the morning at the signal of the cavalry trumpet. But the squadron surgeon of the hussar regiment also found time for science.

Helmholtz was familiar with the problem of perpetual motion since his school years, and in his student years "in his free moments ... he searched for and looked through the works of Daniel Bernoulli, Jean Leron d'Alembert and other mathematicians of the last century." “Thus, I,” said Helmholtz, “stumbled upon the question: “What relation should exist between the various forces of nature, if it is assumed that perpetuum mobile is impossible at all?” - and further: "Are all these relations actually carried out?".

Hermann Helmholtz published in 1845 in Müller's journal "On the Expenditure of Substance under the Action of Muscles". In the same 1845, young scientists grouped around Magnus and Müller formed the Berlin Physical Society. Helmholtz also entered it. Since 1845, the society, which later turned into the German Physical Society, began to publish the first abstract journal, Uspekhi Fiziki.

In 1845-1846, the main ideas of the scientist were formed, which served as the basis of his famous work "On the Conservation of Force". On July 23, 1847, Helmholtz gave a talk on this subject at the Physical Society. In it, he mathematically substantiated the law of conservation of forces (in modern scientific language - energy), showed its universality, introduced the concept of potential energy (in its terminology - stress forces), connected the law of conservation of energy with the impossibility of building a perpetual motion machine.

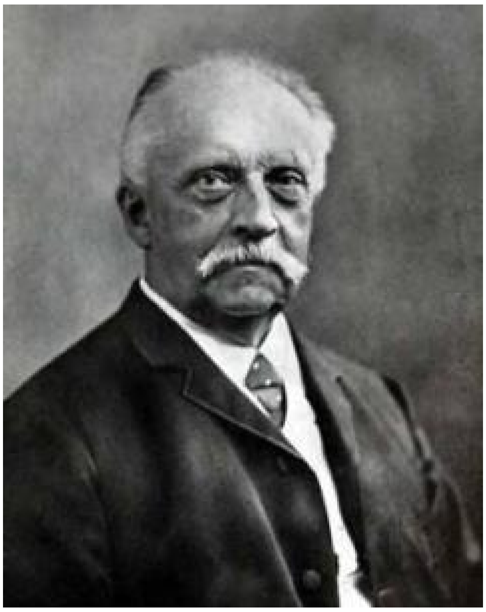


Transferred in 1847 to the royal regiment, Helmholtz met his future wife, Olga von Velten. August 26, 1848 Helmholtz married Olga, and the newlyweds went to Koenigsberg to build their family happiness. Olga not only took on all the household chores, but, being an educated girl, helped her husband in his research. In addition, the Helmholtz House quickly became one of the centers of the city's cultural life: musical evenings were often held here, and amateur performances were staged. In the summer of 1850, the first child appeared in the family - a girl named Catherine Carolina Julia Betty. In 1852 Olga gave birth to a son, Richard.

On the recommendation of Alexander Humboldt, in 1848 Helmholtz was allowed to leave military service prematurely and return to Berlin to take a place at the Academy of Arts as an anatomy teacher; at the same time, Helmholtz becomes an assistant at the anatomical museum.

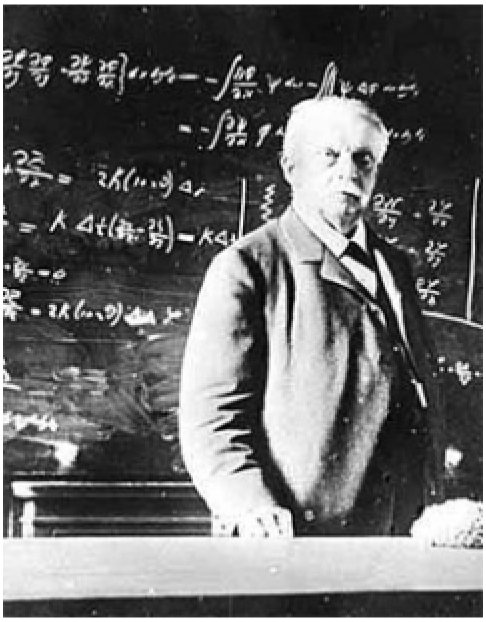
In 1843-1849. Helmholtz worked as a military surgeon in Potsdam. Constant studies in physics allowed him, in 1847, still an unknown squadron doctor, to formulate, independently of R. Mayer and D. Joule, the law of conservation and transformation of energy, the universality of this law, i.e. its applicability to all then known physical phenomena. This discovery brought Helmholtz wide and well-deserved fame. Helmholtz repeatedly acknowledged the priority of Mayer and Joule, emphasizing, however, that he was not familiar with Mayer's work, and knew Joule's work insufficiently.

In 1849, on the recommendation of his teacher, the famous physiologist Johann Müller, he was invited to the post of professor of physiology and general anatomy in Königsberg. Helmholtz highly valued the educational influence of his professor-supervisor Johann Müller and kept to his direction. No wonder he said about him: “He who once came into contact with a first-class person, his spiritual scale is forever changed - he experienced the most interesting thing that life can give ...”.



In August 1853, Helmholtz, leaving his wife and two children with relatives, made his first trip to England, where he met Faraday. In 1854, his beloved mother died. At the same time, his wife's tuberculosis began to threaten her health. Helmholtz began to take measures to move to another city where the climate was milder, and such an opportunity presented itself to him when the department of physiology and anatomy in Bonn was vacated. In 1855 he was appointed to the chair of anatomy and physiology at the University of Bonn.

In 1855, Helmholtz moved to Bonn, where he headed the department of anatomy and physiology, since 1858 - the department of physiology in Heidelberg. In small Heidelberg, two of his close friends, Bunsen and Kirchhoff, were already working as professors. Ivan Mikhailovich Sechenov studied under Helmholtz in this laboratory. How great was the impression made on him by the teacher, can be judged by his following words: “What can I say about this out of the ordinary person? Due to the insignificance of education, I could not approach him, so I saw him, so to speak, only from a distance, never remaining calm in his presence ... From his ... figure with pensive eyes blew some kind of world, as if not from this world. Strange as it may seem, but I am telling the absolute truth: he made an impression on me similar to what I experienced when I first looked at the Sistine Madonna in Dresden, especially since his eyes were really similar in expression to the eyes of this Madonna.



In Heidelberg, his wife's serious illness worsened. December 28, 1859 Olga Helmholtz died. In connection with a severe nervous condition and fatigue, Helmholtz became more frequent fainting, which happened before. In his arms were two small children. A year later, he proposed to Anna Mol, the niece of a professor of Persian at the Collège de France in Paris. Anna spent most of her life in Paris and London, was a highly educated girl. After the return of Helmholtz from England on May 16, 1861, the wedding took place with Anna von Mol. On November 22, 1862, Helmholtz was elected vice-rector of the University of Heidelberg.

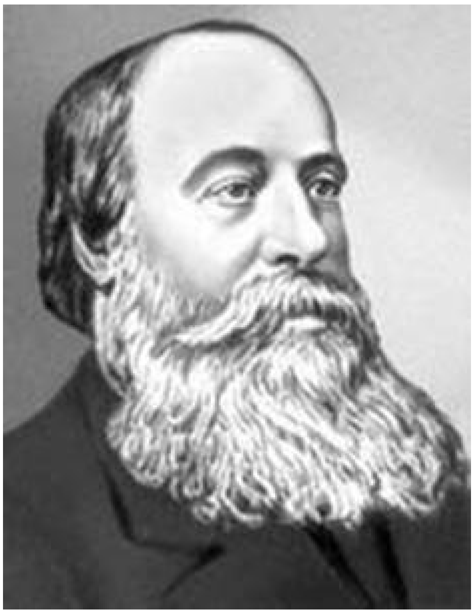
In 1870 Helmholtz became a member of the Prussian Academy of Sciences.

Helmholtz remained in Heidelberg until 1871, when, at the invitation of the University of Berlin, he headed the vacant chair of physics after the death of the famous professor of physics Gustav Magnus.

Helmholtz's work took him far beyond physiology, so it is not surprising that when the Department of Physics at the University of Berlin was vacated, Dubois-Reymond, the rector of the University of Berlin, sent Helmholtz an offer to head the first Department of Physics in Germany. On February 13, 1871, returning from a trip to Switzerland, Helmholtz was invited to Versailles, where Wilhelm I signed his appointment as professor of physics. On this occasion, Dubois-Reymond remarked: "An unheard-of thing has happened: a physician and professor of physiology has taken the main department of physics in Germany."

Soon Hermann von Helmholtz was elected professor of physics at the Medico-Surgical Academy, where he received his scientific education. Here, continuing his work on physiological acoustics and optics, he moved more and more away from medicine, moving on to purely physical questions. He also received a request from William Thomson if he would like to take the chair of experimental physics at Cambridge, where the famous Maxwell and later the most important modern physicist E. Rutherford was the first professor of physics.

In 1873, another family tragedy struck him, the death of his daughter Kate. Helmholtz experienced the loss of a loved one hard. But life goes on.

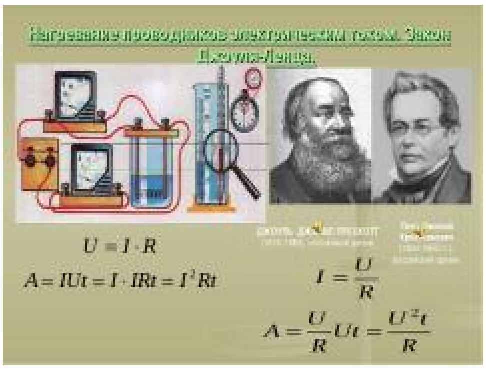


October 15, 1877 Helmholtz was elected rector of the University of Berlin and at the same time published the work "On Thinking and Medicine", which is of the deepest interest to this day.

After Magnus, Helmholtz inherited a small and uncomfortable laboratory; she was the first in Europe by the time of foundation, and he was the second by time its leader. It was crowded and uncomfortable for him in a small laboratory, and with the assistance of the government, he built in 1877 a palace of science, now called the Physical Institute of the University of Berlin, which he controlled until 1888, when the German Reichstag founded a large institution in Charlottenburg - the Imperial Department of Physics and Technology and appointed Helmholtz as its president. Since then, he left the physical institute in Berlin, handing over the leadership to Professor August Kundt, and he himself lectured only of a theoretical nature.

Helmholtz obtained classical results on the physiology of vision and hearing. He invented the ophthalmoscope and created acoustic resonators (Helmholtz resonators).

In the late 50s, Helmholtz turned to theoretical physics - hydrodynamics and electrodynamics.

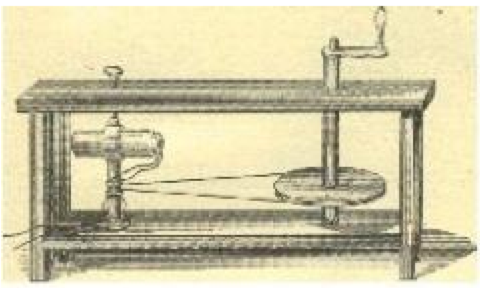


Helmholtz was a versatile scientist, a brilliant experimenter and a great thinker, organizer of science.

He developed the thermodynamic theory of chemical processes, introducing the concepts of free and bound energy, in 1869 he created an oscillatory circuit consisting of inductance and capacitance.

Helmholtz was the first to measure the rate of propagation of nervous excitation.

Helmholtz said: "As far as I remember, happy thoughts never came to me at the desk and when the brain was tired. Happy thoughts often come in the morning. But they prefer to appear during easy walks through the wooded mountains in sunny weather."



Установка Джоуля

In the works of Helmholtz, the foundations of the new science of biophysics were laid. He, in particular, found that red causes irritation, and green calms.

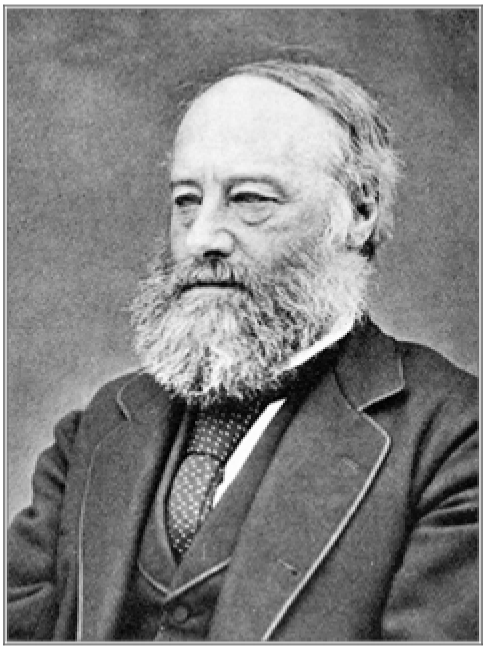
G. Helmholtz stood at the origins of another science - musical harmony. He showed the physiological effect of music on a person.

G. Helmholtz laid the foundations for the theory of vortices and studied wave motions. The results obtained by him were subsequently used by Maxwell and Lorentz.

In 1873, Helmholtz outlined some of the theoretical issues of controlled aeronautics.

Hermann Helmholtz was one of the founders of the theory of "hieroglyphs", according to which our sensations are not images of things, but symbols, hieroglyphs, nothing like objects of nature.

He retained his amazing ability to work and clarity of thought until the last days of his life.

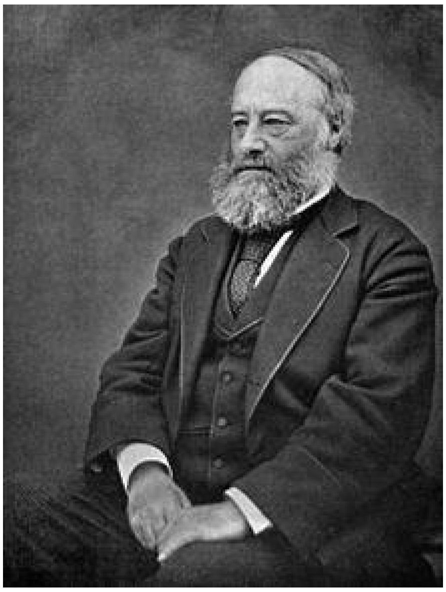


In accordance with the versatile nature of his pedagogical activity, he presented Europe with students - specialists in various branches of natural science. Without listing his students abroad, we note only Russian ones: N. N. Gesehaus, A. P. Sokolov, R. A. Kolli, P. F. Zilov, N. N. Schiller; from biologists and doctors, professors E. Adamyuk, N. Bakst, L. Hirshman, I. Dogel, V. Dybkovsky, E. Mandelstamm, I. Sechenov, A. Khodin, F. Sheremetevsky, E. Junge, of which many acquired big name in science and founded schools in Russian universities.

From the portrait of Helmholtz, a strong-willed, imperious face looks at us, the tips of a thick gray mustache are lowered down. An impeccable suit. A piercing somewhat heavy look. Hertz addressed him only as "Your Excellency."

Son Robert, a young scientific physicist who received a prize for his work "On the Radiation of a Flame", died in 1889.

On April 5, 1881, in a speech dedicated to Faraday, Helmholtz for the first time clearly expressed the idea of the atomic structure of electricity. He said: "If we admit the existence of chemical atoms, then we are forced to conclude from here further that electricity, both positive and negative, is also divided into certain elemental quantities, which play the role of electricity atoms."



Even while studying the problems of localizing visual impressions in the field of view, Helmholtz came to the conclusion that all the axioms of geometry have an experimental origin. After studying the works of Lobachevsky, Helmholtz proposed a model of variable curvature space as "the image field of a convex mirror or lens." In the book "Counting and Measurement" Helmholtz considered the substantiation of its automatic applicability to physical phenomena as the main problem of arithmetic. Proceeding from the fact that the very concept of number is borrowed from experience, Helmholtz believed that real numbers and their properties are applicable only to these experiments, in which the objects under study should not be transformed (as A. Lebesgue joked, “by placing a lion and a rabbit in a cage, we will not find two animals in it later”). According to Helmholtz, even the concept of equality does not automatically apply to every experience.