they could not fail to come in contact before vitality is lost. A half hour after contact with the milt, the eggs swell and become too hard to be broken by pressure of the thumb and finger. Their specific gravity is now so nearly equal to that of salt water that when the water is at rest they float upon its surface, remain suspended in the water, or occasionally sink slowly to the bottom. The least current will cause them to be distributed through the liquid. Mr. Earll discovered a small oil globule in each egg which serves the purpose of buoying it. The impregnated egg is also so transparent that the fishermen, who are not usually very observing, would never suspect their presence. The eggs are smaller than eggs of almost any other species, and have an average diameter of only one-twenty-eighth of an inch. It has been estimated, it will be seen, that 21,952 would make a cubic inch, and a quart of 57¾ cubic inches would hold 1,267,728 eggs.

The period of hatching is greatly influenced by the temperature of the water. The average temperature during the experiments at Crisfield was 84° Fahrenheit. Ten hours after contact with the milt the outline of the fish could be discerned by the naked eye. The fish is formed with the curve of the back at the lowest point of the egg. In fifteen and one-half hours the fish began hatching. In eighteen hours one-half of the eggs had hatched, and in twenty hours all were out. Experiments in water at 78° Fahrenheit showed that twenty-four hours were necessary for hatching. A more remarkable effect of temperature is observable in the case of the cod. In water at 45° cod have been hatched in thirteen days, but in water at 31° fifty days were occupied in hatching.

The newly-hatched mackerel are about one-eighth of an inch in length, and so small as to escape through wire cloth with thirty-two threads to the inch, and are almost colorless. The food sac, situated well forward, is quite large in proportion to the body, the anterior margin extending to the lower jaw. While floating on its back for several hours, during its helpless condition, it passes safely over the heads of its enemies, and is protected from being wrecked in sand or weeds. After a few hours, becoming more vigorous, it gets to a depth of an inch or more below the surface of the water. After a day or two the food sac is less prominent, and the fish experiences less difficulty in swimming at various depths. The young mackerel hatched by Mr. Earll were so hardy that forty were confined in a goblet without change of water for two days before the first fish died; others placed in water which was allowed to cool gradually and immediately transferred to water ten degrees warmer, were not injured in the least. In fresh water they slowly sank and died in a few hours. Mr. Earll also found that a fair percentage of eggs could be hatched in still water with but one or two changes during their development. Eggs taken at 6 P.M., and allowed to remain in a basin of water till morning, when another change was made, hatched with very small percentage of loss. Samples of all the different stages of development were preserved in alcohol and glycerine for the National Museum. Over half a million were hatched by the various methods and at various times.

The apparatus used in these experiments consisted simply of floating boxes with bottoms made of wire cloth. The cloth was plated with nickel to prevent injurious action of the salt water, and contained thirty-two wires to the inch. After it was found that a lot of fish had escaped through it, only the shells remaining to prove that hatching had actually taken place, the wire and each aperture were covered with coarse cotton cloth. The boxes were provided with covers for protection against storms, or wind, or rain, but were provided with openings on the sides to admit fresh water from above.

The commissioner has been intensely gratified at these results due to the ingenuity of Mr. Earll. They open the way to the systematic propagation of the species in waters where they do not now exist, and to the countless multiplication of them in the Chesapeake. The season being in mid-summer will not conflict with the shad season of the Spring, the salmon season of the Fall, or the cod season of the Winter. The eggs are much more abundant and hatch more easily and rapidly than those of any fish now propagated. During the four days consumed in hatching a lot of shad, five lots of mackerel could be hatched, and during the twenty-four days necessary to hatch one lot of cod-fish, thirty-two lots of mackerel would be produced. A suitable station for hatching was chosen at Cherrystone, Md. The fishermen are kindly disposed and will render every assistance. It is hoped that young fish may be thus successfully planted as far North as Narragansett Bay.

SMITHSONIAN INSTITUTION, Washington, D.C., *November* 6, 1880.

THE ISLAND OF MONTREAL.*

By WILLIAM BOYD.

A considerable portion of the waters of the Ottawa, at the foot of the Lake of Two Mountains, divides on the Island of Montreal. The branch that is directed to the northern part of the island soon sub-divides on Isle Perrot. There rapids are in each of the sub-branches. The sub-branches encounter the St. Lawrence on its northern side at two points,—shortly after it leaves the Cascades Rapids and below Isle Perrot, from that island's inner shore. The waters of the St. Law-rence bound also, indirectly, the southern side of the Island of Montreal, flowing in the same river-bed with the Ottawa, but beyond or outside its stream. The water of the St. Lawrence is greenish, that of the Ottawa reddish-brown. The two rivers run side by side unmixed to the Ottawa's lowermost mouth, at the foot of the Island of Montreal; and thence onward in the same manner, with increased volume on the part of the Ottawa, to Lake St. Peter, where they finally mingle. If the Ottawa should cease to exist and the St. Lawrence remain, what is now the Island of Montreal would probably—from the high level of the then Lake of Two Mountains, and from a great fall which would, on the extinction of the Ottawa, take place in the St. Lawrence below the Cascades Rapids—be an island no longer; but if the St. Lawrence should disappear and the Ottawa remain, the Island of Montreal would continue to be an island still. Therefore the writer is of the opinion that the Island of Montreal is an island not in the St. Lawrence as has heretofore been held, but in the Ottawa.

FRIEDRICH MOHR'S LIFE AND WORKS.

By DR. GEO. W. RACHEL.

On September 28, 1879, *Prof.* FRIEDRICH MOHR, one of the greatest philosophers Germany has ever produced, died after a short illness at *Bonn* on the Rhine. He was born at Koblenz on November 4, 1806, and, therefore, at the time of his death, was nearly 73 years old. In spite of this advanced age, he remained active and bright almost to the very moment of death, dictating to his daughter Anna until within a few hours of it in his usual clear and coherent manner.

His father was a pharmacist and proprietor of one of the principal drug-stores of the town; he is described as having been unusually proficient in the arts of his trade, and an ardent lover of his special profession as well as of science in general. A wealthy man, comparatively speaking, he bestowed great care on little FRIEDRICH, the only surviving child of six. The opportunity offered to the sickly, quiet boy who had to be kept from school during the greater part of his boyhood, was eagerly taken advantage of by him. Test-tubes and retorts almost took the place of play-toys with him, and his involuntary leisure enabled him to lay the foundation for his future greatness, viz.: an ability for labratory work almost unsurpassed. Thus it was that his methods as well as many of the instruments and apparatus he devised, are found to-day in every laboratory and are used all over the globe wherever chemistry has an abode.

* Read before the A. A. A. S., Boston, 1880.

In spite of the loss of time, occasioned by his continued ill-health, his sharp, grasping intellect enabled him to pass with honors the examination for admission to university study (*Abiturienten-Examen*) at the comparatively early age of seventeen (1823). After five years of further practical work as an apprentice and clerk in his father's store and pharmaceutical labratory, he went to *Heidelberg* (1828) studying chemistry with GMELIN. After another lustrum spent in various studies, there as well as at *Berlin*, and finally at *Bonn*, he returned to his home at *Koblenz* (1833) with the degree of *Ph. D.** After having passed his *State's Examination*, he married, and had, at the time of his death, two daughters and two sons. The faithful companion of his life, an excellent wife and mother, also survives him.

In 1840 his father died and he then took charge of the inheritance faithfully, and for seventeen years conducted the *Mohren-Apotheke*, as the establishment was popularly called. In 1857, however, he disposed of it in order to devote, in retirement, his entire energies to scientific research. He did so for a period of about six years, and then had the misfortune to become involved in pecuniary difficulties arising from the failure of a manufacturing establishment belonging to his son-in-law, in which he had been special partner. The honest fulfillment of all his engagements cost him nearly all his fortune, and was the direct cause of his removing to *Bonn*, where he settled in 1864 as lecturer (*Privatdozent*). The chair of Pharmacy becoming vacant a year and a half after his settlement at *Bonn University*, he was appointed to the place. He owed this appointment to the direct influence of *Emperor* then *King* WILLIAM, and the *Empress* then *Queen* AUGUSTA. The latter always took a lively interest in his welfare, which dated from their long residence at *Koblenz Castle* before the Prince's accession to the throne. The Princess had always been fond of the great man's company, his conversational powers and his manner of reading being of an unusually high degree of perfection.** In a letter to the writer, his accomplished daughter, *Miss* ANNA MOHR, who acted as his amanuensis for many years, states:

"In our family circle where he felt himself surrounded by loving care, I have never seen him otherwise than happy and contented. Full of feeling and sparkling with humor, he always was appreciative of everything that is noble and beautiful in art and nature. Music and poetry were always especial favorites with him and while BEETHOVEN, MOZART, HAYDN and WEBER were his ideals in the former, GOETHE, SCHILLER, SHAKSPEARE, HOMER, etc., were to him as old acquaintances. His wonderful memory enabled him to recite for hours SCHILLER'S Ballads or his *William Tell;* GOETHE'S *Faust;* HOMER'S *Iliad*, and many, many other works of those and other poets. And not only was his recitation masterly and perfect, his reading power of serious, as well as of comical pieces was unsurpassed. . . . . He would at the same time master any dialect, new to him, in a few hours, and his many friends and acquaintances owe him many hours of bliss and happiness and many a pleasant evening."

After having thus fonnd a congenial sphere of action, his genius—no longer dragged down by pecuniary cares—attained full sway. In quick succession he published that series of, not very numerous, yet very important, works which will make his name immortal. His lectures also, those at the University as well as many others which he delivered in clubs and societies at *Bonn, Cologne, Koblenz, Krefeld* and other neighboring cities and his many contributions to scientific as well as other magazines and periodicals won him the hearts equally of his students and his lay-hearers. Of this the immense throng of people, belonging to all classes of society, that attended his funeral, was a sure indication.

But, in spite of all this popular recognition, he was not allowed to take that commanding position to which he was entitled by the superiority of his genius. We need only remind the reader of DR. AKIN'S letter published in No. 15 of "SCIENCE," to suggest the causes for the otherwise almost incomprehensible fact that MOHR remained an "*Extra-Ordinarius*" up to the time of his death. The reason is obvious. Even the Hohenzollern did not undertake serious intervention in his interest in regard to this matter; for, although his loyalty and patriotism were proverbial, his radical views in regard to things theological which he always fearlessly confessed, and his unflinching attacks on erroneous views in science, regardless of what position those who proclaimed them might chance to hold, were sufficient causes for the failure of the powers that be to promote his attempts. He remained undisturbed because he recognized *authority* in matters political, but he was not promoted, because he did not feel bound by any *authority* in theological and scientific matters, unconditionally.

The *Emperor* desisted from interfering after experiencing a resistance on the part of "*Cultusminister* FALK" against MOHR'S promotion, which he could not overcome.

When MOHR settled at *Bonn University* as a *Privat-Dozent*, he was 57 years of age, *i. e.*, older by several decades than the average of his colleagues, being the senior of most members of the regular faculty themselves. But more than this, he had already at that time shown his inclination and his ability to reform, nay, to revolutionize some of the many branches of science which he mastered (theoretically and practically). This was more than mediocrity and even famous men are willing to endure. And to just such influences MOHR himself—who knew all the various intrigues against and reports about him, which he never raised his finger publicly to lay bare or refute—attributed the bad treatment which he received.

His eldest son, MR. CARL MOHR, an able chemist, and an accomplished contributor to scientific magazines, writes feelingly, about this matter, as follows:

". . . . yet it would be interesting to expose without fear or favor the dark doings of that '*official science*' of such men as ——, ——, ——,* etc. These men do not want to recognize anybody as their equal who does not sail under their colors; followers and panegyrics are all they care to be surrounded with. But they hate and fear men of an independent turn of mind who dare have convictions of their own and dare express them, regardless of consequences to either themselves or others. Father has, for instance, by his sharp and telling hits of criticism in his Commentary to the '*Pharm. Bor.*' made enemies of the whole official clique of ——, ——, ——, and others at *Berlin*. Those men, instead being thankful to a man, far superior to them, who has pointed out errors, and shown how to correct them, have persecuted him to their hearts' content. When, therefore, the commission for the preparation of the '*Pharmacopœa Germanica*' was to be appointed, he was excluded from the list of commissioners intentionally and ostentatiously. The man who really was the *Nestor of Pharmaceutics in Germany*, author of such unrivalled standard works as his '*Pharmcopœa universalis*,' the *Commentary*, etc., above referred to, a 'Manual of Pharmaceutical Practice,'** a 'Text-book on the Art of Dispensing,'*** and others, was ignored in such a disgraceful manner. It was a shameful performance, one that has no equal in the whole history of Science."

The narrative of these occurrences is one of the best illustrations of DR. AKIN'S views, as expressed in his letter to PROF. STOKES, alluded to before.

But, although the illustrious man was thus slightingly treated by men, generally far inferior, none of them superior to him, principally on account of his superiority and of the fact that most of his views and arguments were un-

* The honorary title of *M. D.* was conferred upon him in later years; he also received the title of *Medizinalrath*, and was for a period of over thirty years the pharmaceutical adviser and member of the *Rhenish Medical Council*. He furthermore was elected corresponding or honorary member by several academies, numerous pharmaceutical and scientific associations in general, among the former being the *American Pharmaceutical Association* and the *Philadelphia College of Pharmacy*.

** He at this time delivered a course of lectures to *Princess* AUGUSTA at his house, comprising experimental chemistry and applied mechanics (models of steam-engines, etc., being prepared for this special purpose), the *Prince* and his eldest son (now the *Crown Prince of Germany*) attending when they stopped at the Castle.

* The list of names—I am sorry to say—embraces some of the most renowned professors at *Bonn* and at *Berlin*. MOHR'S intention was, as I am informed, to give a detailed account of the various intrigues against him in a work he was about to publish, when death overtook him; to accuse his persecutors and enemies, and lay at their door the guilt, of having deprived him of due recognition and promotion to the place and honors of an '*Ordinarius*,' and to justify before the public his conduct of not having until then stooped to answer and refute the indignities thus heaped upon him. G. W. R.

** *Lehrbuch der Pharmaceutischen Technik;* published in *six* editions (first, 1846) trveral times translated into French and English.

*** Rezeptinkunst.

answerable,* he was highly esteemed by the independent members of the profession at large in Germany. The last meeting of the '*German Apothecaries' Association*' which he attended, reading the inaugural address, was made the occasion of quiet and impressive ovations which the modest man received with deep feeling. The kind and respectful regard with which the venerable scientist was treated by almost all the members present, was often referred to by him in his family-circle with pride and satisfaction during the twelve months which were still allotted to him. He felt at that day, if ever, that he had not lived in vain, and that the seed which he had sown would not be lost, but that coming generations would yet profit from and be benefited by it.

Besides the works mentioned, he wrote the following: *The Mechanical Theory of Chemical Affinity, etc.;*[1] *General Theory of Motion and Force as a basis of Physics and Chemistry:*[2] *Manual of volumetric Analysis;*[3] edited five times, and last, but not least, a *History of the Earth; Geology founded on a new basis,*[4] which was edited twice.

Of the various improved analytical methods devised by him may be mentioned the proposal to use oxalic instead of sulphuric acid (GAY-LUSSAC), to determine the relative proportion of alkalies and acids contained in a salt; his combination: Sodic Carbonate against Iodine-solution; or, better still, Sodic Hyposulphite against Iodine-solution, and his beautiful determination of Chlorine, by the use of Argentic-Nitrate-Solution, with Potassium Chromate as indicator; of the many instruments invented by him, the self-acting stirring apparatus, with clock-work arrangement, a pill-machine, an apparatus for preparing infusions by the use of steam, another for extraction by means of ethers, and his improved burette, with compressing faucet. His *Manual of Volumetric Analysis* in which these devices and many others of like importance are described, is considered one of the first standard works in the domain of analytical chemistry, and has been translated into various languages.

The attempt, first made by him in his *Mechanical Theory of Chemical Affinity*, to promulgate the theory that chemical affinity is a mode of motion, inherent in matter, and is measurable only in so far as we can measure the heat that is liberated and bound up during the union or separation of two elements, is one of his greatest efforts. LIEBIG† himself always valued this work very highly, and it is certainly one of the most brilliant manifestations of MOHR's genius, as will be seen from the following extracts:

"The union of two bodies by combustion always liberates a certain portion of this motion which appears in the shape of heat. Another portion remains in the product of combustion. We are only able to measure the former, not the latter, and even of the former we are unable to say how large an amount is due to one body and how much to the other. If one gramme of hydrogen unites with eight of oxygen, 34,462 units of heat are liberated. These indicate the amount of motion which both gases contained when yet ununited, as compared with the water resulting from the union. In the latter itself there is yet a certain amount of motion, as its liquidity and its proneness to vaporization successfully prove. From the oxygen contained in the water we are able to liberate yet another amount of heat by uniting it with potassium or with zinc, because potassa and zinc oxide are more apyrous than either potassium or zinc. Now, it is impossible to know what portion of the 34,462 units of heat comes from the hydrogen, and which from the oxygen, and furthermore, what amount there is yet in the water. Therefore, we cannot reduce to an absolute measure this property of chemical affinity, only the portion that is liberated in the shape of h at.

"This example also shows how enormously more efficient the motion that bodies contain as chemical affin'tv, is than that which they contain as heat. The water produced (9 grammes) contains 9 u. of h., while the mixture of both gases before union, contained only 2¼ u. of h. (the specific heat of hydro-oxygen-gas being 0.25). But, since there was a development of 34,462 u. of h. during their union, by combustion, it follows that the motion existing in the mixture as chemical affinity, is 15,316 times that contained in it as heat."

Again:

"If iron develops heat while oxidizing, the dense condition of the oxygen in the resulting ferric oxide is certainly an effect due to chemical affinity, but the potential energy of the oxygen is no longer found in the oxide; it has been separated. The heat liberated during the combustion of the iron in oxygen-gas is the surplus of motion which iron and oxygen contain more than Ferric Oxide."

And again:

"If carbon and oxygen unite to form carbonic acid, there is no change of volume, and so it is with a mixture of chlorine and hydrogen. Their specific gravity after chemical union is the same as before such union took place, because their volume remains unchanged; yet a great amount of heat has been liberated.

"Thus it is not true, as has been formerly assumed, that we may compare—for the purpose of measurement—chemical affinity to mechanical force by calculating the amount of force necessary to compress a mixture of gases so as to give it the density possessed by the product resulting after chemical union has taken place. (Hydro-oxygen-gas against water."

The quintessence of this unique volume is contained in these two theses:

1. Loss of chemical affinity or liberation of heat always means: *Higher specific gravity, higher melting point, higher boiling point, insolubility, chemical indifference, rigidity and development* of but *little heat* on combustion.

2. Increase of chemical affinity and absorption of heat always mean: *Lower specific gravity, lower melting point, increasing solubility, proneness to chemical combination, softness, development of much heat* on combustion.

Mr. CARL MOHR, in a biographical sketch of his father's life and works, says of them:*

"These two axioms comprise almost the whole range of chemical processes, and they are a *mechanical theory of chemical affinity*, in the very same sense that we have a *mechanical theory of heat.*

"As an example to illustrate the first thesis, the reader needs to be reminded only of the chemical relation that exists between acids and bases: sulphuric acid against alkalies, such as caustic potassa or quick-lime. The process of saturation is accompanied by the liberation of considerable heat; the products have a very high melting point and are chemically indifferent.

"To illustrate the second thesis, a good example is the formation of carbon sulphide. As is well known, this process requires a considerable expenditure of heat, and the product thus obtained is volatile at a temperature far below the degree of temperature required for its formation. This heat, taken up by the carbon sulphide, is contained in it as chemical affinity, and is evident by its low specific gravity, its low boiling point, its proneness to decomposition, and the increased development of heat during the combustion of its elements."

The great principle underlying all this reasoning is that of "*the conservation of energy and the correlation of forces,*" of which, as we have shown, he was the first exponent.†

[1] Mechanische Theorie der chem. Affinität; Braunschweig, Fr. Vieweg & Sohn; 1868.

[2] Allgemeine Theorie der Bewegung und Kraft, als Grundlage der Physik und Chemie; Braunschweig, Fr. Vieweg & Sohn; 1869.

[3] Lehrbuch der chemisch-analytischen Titrirmethode; Braunschweig, Fr. Vieweg & Sohn; 1855 (1877).

[4] Geschichte der Erde; eine Geologie auf neuer Grundlage; Bonn, M. Cohen & Sohn; 1866 (1875).

* Many of the suggestions contained in his earlier works were made use of in the '*Pharm. Germ.*' by the very men who were his life-long enemies, because these and other views were freely and sometimes sharply expressed by MOHR. Many of his original ideas on other subjects than *Pharmaceutics*, especially those on *Geology*, were also confirmed by later evidence; but this equally did not serve to reconcile his opponents in this line of research which comprised nearly all '*official geology*' in Germany.

† At the eve of its publication, the great chemist wrote to MOHR as follows:

"I am impatient to see your new book, for you seem to have treated in it of nearly everything that we need to know something definite about, in order to make chemistry a real science; nobody as yet has really had a clear conception of affinity; we simply stuck to facts, that was all. It has been just so with the melting-po'nt, the gaseous condition, the boiling-point, etc."

* *Archiv der Pharmacie;* Vol. 216, 1880.

† See the paper published in No. 17 of "SCIENCE."

The work, as may be gleaned from the few quotations given above, abounds in a variety of new and original ideas, many of them elaborated, others rather fragmentary, but all of them bearing the stamp of the author's genius and containing an inexhaustible source of information and elucidation on the somewhat abstract subject of chemical theory. It may be added that MOHR does not approve of the modern valuation of atoms, but uses exclusively the old formulæ.

The *Allgemeine Theorie, etc.*, is written in the same vein, in fact it is introduced by the author as a supplement to the former, the 'Mech. Theory of Chem. Aff.' Its purport is to lay out the different regions of physics as far as they relate to motion and force; it also gives an outline of the method by which the correlation of forces and especially its grandest practical achievement, the 'Mechanical Theory of Heat,' should be made the basis of natural philosophy.

MOHR insists particularly on the complete eradication of the wrong use of the two words: motion and force: "Motion (*actual energy* of the English writers) implies a change of place, and consequently force (*potential energy*) comprises those states in which a change of place does not obtain." (l. c. p. 12).

"Steam force is therefore a correct expression and designates the tension (potential energy) of the steam. As soon as the piston moves, the tension disappears (potential is converted into actual energy). In the flying wheel and the balancier we have motion (actual energy) and *not* force (potential energy) when 'running empty,' but motion *and* force, when there is some work done at the same time" (Ibid.)

The translation of these few passages will suffice to show the principal aim of the author: To obtain perfect clearness of expression by distinguishing between the two forms, to either of which every '*causa efficiens*' in nature belongs, viz., force (potential energy) and motion (actual energy). Prompted by the same desire, he makes these divisions in classifying those '*causæ efficientes*,' to wit:

"A. MOTIONS.

1. *Motion of bodies* or *progressive motion.*
2. *Light* and *Heat* in the state of radiation or *radiating motion.*
3. *Common, conducted heat* or *conducted motion.*
4. *Galvanism* or *flowing motion.*
5. *Chemical Affinity* or *clinging inherent motion.*

B. FORCES.

1. *Gravity.*
2. *Magnetism.*
3. *Electricity.* (*Static.*)
4. *Cohesion.*"

This division is based on the property of introconversion which is peculiar to the former, not to the latter. The five 'motions' are introconvertible and also convertible into either of the latter (the forces), while these are only convertible into the former.

The reason for his peculiar view that *heat does exist in two different forms of motion*, he states in these words:

"After due consideration of the matter in question, I feel compelled to separate *radiating* from *conducted heat* Radiating heat is not really heat: it does not expand bodies; it does not act on the thermometer nor on the thermo-electric column. That is what conducted heat does. The fact that radiating heat is converted into conducted heat, as soon as it strikes a body which does not reflect it, is no reason why we should declare the heat-rays to be heat already, for the luminous rays and the galvanic current must undergo the same change (before being capable of acting on the thermometer or on the thermo-electric column.) The mode of motion obtaining in the heat-*ray* differs so radically from that in *conducted* heat, that the separation adopted above seems to me fully justified. The circumstance that the heat-ray does not penetrate the different fluids of our eyeball, or if it do penetrate them, is not transmitted through the optic nerve, constitutes only a mechanical difference as compared with the visible ray of light, and we justly conclude that this depends entirely on their different wave-length."

The manner in which the various modes of motion and of force are measured by means of the application to them of the mechanical theory of heat, is particularly dwelled upon. From this it appears that of the *five* modes of motion, *two* only—mechanical motion (of bodies) and heat are reducible to absolute measurement. These two may be compared by means of the unit of heat, expressed in kilogrammometers.

Another line of thought which MOHR has first dared to follow and to pronounce upon, is the one dealing with the real value of the use of mathematical expressions in natural philosophy.

He holds that the value of mathematics is only secondary, and is, as a rule, greatly overrated. He says:

. . . "For, such propositions are proved by logical reasoning only, not by applied mathematics. A formula is nothing but the mathematical expression of the true inwardness of certain phenomena, as it has been previously found by intellectual observations and reasonings. What is obtained as a result through the formula, is in it from the beginning; it is not at all a discovery made by the mathematic an. If the first equation is wrong, the conclusions arrived at will be wrong. The ancient mathematicians who knew nothing of algebra, logarithms and the differential calculus, had to reason logically exclusively; even the lack of the Arabic numerals was a great drawback to them. That we are able, by the help of all these advantages, to deduce quicker and more accurately a number of relations from a given equation, only diminishes the intellectual merit of our work but not the practical value of the result. Mathematics have only one object, to wit: to evolve from certain given conditions the unknown quantity."

It cannot be denied that there has been, of late, an obvious tendency to overestimate the value of mathematics in the philosophical investigation of physical problems. And it is not the least of MOHR'S many merits that he has conclusively shown that their importance is, secondary only, and that their intrinsic value is far below that of logical deductions. "A mathematician can never discover a new law in physics; that is done by observations only and by the logical reasonings, based on such observations."

By thus defining the proper limits and the legitimate domain which mathematics should occupy in natural philosophy, MOHR has certainly rendered an invaluable service to numerous students of nature. Great numbers of such have been frightened by the many hundreds of pages filled with mathematical formulæ, with which we now see treatises on physics so profusely interspersed.

A perusal of this somewhat fragmentary work does not fail to leave the impression in the mind of the reader what a great misfortune it was that the author should have been called away before he had given us a more complete and comprehensive treatise on the subject; numerous requests addressed to him with this view were invariably met, as we are informed, by a modest decline, on the ground that much was to be done before this could be ventured upon.

His immense capacity for progressive thought is best illustrated by quoting from one of the "*Appendices*," happy after-thoughts, to this work. There he says:

"In determining the conception of the word *force* in contradistinction to *motion*: gravity, cohesion and magnetism seem to be without any inherent motion, as we have no indication that there is such motion. On the contrary, the tension of compressed air, the action of an explosive mixture, etc,, appear in the form of inherent molecular motion, which could appear dead only in comparing it to mechanical motion (of solid bodies). In a compressed gas there is perceptible heat and chemical affinity (motion). The perceptible heat acts on the thermometer only, but not as a force on the walls (of the enclosing vessel), while that amount of heat which is available for expansion, and which, while the (movable) wall of the enclosure (piston in cylinder of steam engine) is receding, is actually used for expansion, implies tension directed outwardly. Since, therefore, we recognize in this the effects of actual energy (*motion*) as being of the same nature as those of potential energy (*force*—gravity, for instance), acting by pressure or tension (supported or suspended weight), the question arises *whether magnetism, gravity and cohesion are not different forms of an inherent molecular motion of which we have, as yet, not the slightest conception.*"

This idea has occupied his mind during the last years of his life particularly, and he has published one of a series of articles* on the subject of cohesion and the atomic theory, the latter of which he attacks with all the acuteness we are wont to find in his writings.

In regard to MOHR's *Gesehichte der Erde*, which he rightly calls: *Geology on a new basis*, it is impossible to say little, if it should be spoken of at all. Suffice it, however, to state that it is not what is usually called *Neptunism* what MOHR advocates; it is free from any kind of "ism," as the man who wrote it himself was. But in the generally accepted plutonistic geology, fire plays such an omnipotent *rôle*, that any deviating view, any appreciation of the true state of things geological, is believed to deserve that name from the outset. The so-called Neptunism of MOHR has, however, nothing in common with the impossibilities of the Old Neptunistic School of WERNER and his followers.

There is this radical difference between the views, as yet generally accepted, and those advanced by MOHR:

His aim is to show *in what manner* the several minerals and rocks, composing the outermost, accessible strata of our earth, have been formed; the *question of time* he considers to be not only irrelevant, but also very difficult of ascertaining. His firm conviction of the falsity of the nebular hypothesis and the previous fluid state of the earth and the present molten state of its interior has been strongly supported of late, not only by other *savants*, but by a number of facts and reasonings. The foremost among the former is embodied in the results of careful measurements of temperature in the deep boring (4052') at *Speremberg*, near *Berlin*, conducted by the most learned and experienced mining officials of the Prussian Government. They show that the old supposition of 1° C. increase of temperature to each 100' is fallacious, and that this increase diminishes constantly in going down. Here is the table:

Depth.	Temperature.	Increase per 100 ft.	
700 Rh. ft.	15.654° Réaumur	1.097° R.	2.468° F.
900	17.849	1.047	2.356
1100	19.943	0.997	2.243
1300	21.937	0.946	2.128
1500	23.830	0.896	2.018
1700	25.623	0.846	1.904
1900	27.315	0.795	1.789
2100	28.906	0.608	1.368
3390	36.756		

While for the lowest 100 feet it was: 0.445° R. (1.001° F.)

"This would make the final result, as stated by MOHR," says Dr. KLEIN,* "very well founded, nay, indisputable, viz.: 'that the increase of temperature *will cease altogether*;' not at a depth of 5000' or 6000', as MOHR will have it, but, at all events, at a depth considerably below 100,000'."

Thus, in addition to the many astronomical, physical and chemical reasons, which are irreconcilable with the nebular hypothesis and with the theory of the molten interior of the earth, derived from this hypothesis, MOHR has pointed out an irrefutable fact which supports this position.** For, continuing the slight increase found in a proportionate ratio, at the point where there will be no more increase, the temperature actually obtaining will fall much below the melting point of lead; this had been predicted by MOHR on other grounds, before the measurements made at *Speremberg* had been published.

Chemistry, especially, is ingeniously applied to geology in MOHR's work, and from the chemical constitution and physical properties of the various minerals and the rock-formations which they compose, conclusions are arrived at which throw a new light, in many cases, on the probable origin and subsequent metamorphosis of the various component parts of the surface of our globe. To mention only one important result, we may refer to the different properties of the Silicate rocks having volcanic origin, as compared with those having, until lately, been supposed to have a 'plutonic' origin. The several properties which the one kind possesses are not found to be properties of the other, and MOHR, therefore, takes strong ground to deny their fiery origin.

Among these properties, demonstrating their crystalline origin, may be mentioned the following:

1. That Feldspar, Augite, Hornblende, Mica, Rock-crystal, Quartz, etc., as well as the rocks which are composed of these minerals, all show minute cavities containing water which are not found in rocks that have undoubtedly been molten, such as Obsidian and other lavas.

2. That the specific gravity of the silicic acid contained in them is greater (2, 5—2, 6) than that in volcanic rocks (2, 5—2, 3).

3. That by melting these crystalline rocks (Basalt, Granite, etc.,) their specific gravity is reduced in the same proportion.

4. That petrified wood, fossils, and other pseudomorphoses of organic origin, and even organic matter unchanged (Asphalte in Granite), is found to be enclosed in them.

5. That the crystalline rocks decay much easier and quicker than the volcanic molten rocks.

6. That many chemical actions, combinations, etc., would be impossible if a molten condition was presupposed, etc.

These and other properties of less importance undoubtedly form a strong array of proofs against the '*plutonic*' or fiery origin of the Silicate Rocks.

The formation of lime-deposits takes place according to MOHR in the ocean by the following bio-chemical processes:

The sulphate of lime contained in the sea-water is assimilated by the marine plants (*Algæ* and *Fucus* especially), and by them decomposed in the course of their vital processes. While the sulphur enters into albuminous compounds, the lime unites with carbonic acid, and both go to form part of the plant itself. The plants serve as nourishment to the myriads of minute animals (*Rhizopoda* and *Foraminifera*), which populate the oceans, and while the carbonate of lime serves to build up their shell, the sulphur is eliminated by their bio-chemical process as sulphurous and hydrosulphuric acid. These shells which lie from 10 to 15 feet deep at the bottom of the oceans, are the chalk and lime-beds of the future.

The presence of organic matter in meteoritic masses and the absence of carbon in meteoritic iron are pointed out by MOHR as further proofs against the plutonistic and in favor of the crystalline origin of the heavenly bodies. The chapter on these mysterious visitors from the celestial spaces is the longest and certainly one of the most interesting.

His views, especially in regard to the constant metamorphosis of rock-strata, are in fair way of becoming generally accepted—although his name is not as yet mentioned in connection with them.*

Another theory which refers the formation of coal-fields to the deposition of immense masses of sea-weeds and tangs at the bottom of the ocean, has been greatly supported by the discovery that Iodine and Bromine are regularly found in the smoke-black from chimneys where coal is burned.

The book abounds in new and original researches as well as in bold deductions; and even those who do not agree with the author will find in it an almost inexhaustible source of information, and will experience that great delight which the writings of a great thinker always give to an impartial reader.

In conclusion, it may be safely said that MOHR belonged to those whose writings and the results of whose labors will not lose interest as time passes, but will rather be more and more generally appreciated. He has said or written but very little that he was forced to revoke; on the contrary, many of his views have stood against the attack of time and of his adversaries, and many of the latter have been forced to admit that he was right.

Personally, as has been mentioned already, FRIEDRICH MOHR was the most amiable of men, and the Editor of the '*Gaea*,' DR. H. KLEIN, who was a near friend of his during many years, rightly says of him (in a private letter to the writer):

"In every respect MOHR was a man who would be an ornament to any period of Human History."

*LIEBIG's "Annalen;" Vol. 195, 1879; pp. 133-213.

NOTE.—The rest of this series which the editor of the *Annalen* declined to publish, are those mentioned in the foot-note on p. 203 of No. 17 of this journal.

* *Die Fortschritte der Geologie*, 1874-'75; *p.* 57.

** In a future article this subject will be exhaustively treated, and the position, taken by VOLGER, MOHR and RADENHAUSEN in regard to the nebular hypothesis, as well as that of *Sir* WILLIAM THOMSON POULET, SKROUP, STERRY HUNT and others in regard to the Earth's molten Interior, will be thoroughly treated of and criticized. A letter, also, from the pen of one of America's first astronomers will be quoted, in which this eminent scientist states his views on the subject in a manner which adds the additional weight of his superior authority to the evidence adduced agaihst this Hypothesis. G. W. R.

* Strata of Shales, Mica-Schist, Calcareous Schist and Gneiss not infrequently are so uniformly spread out, in the same locality, that there can be no doubt of their common origin.