A second obstacle has been the lack of agreement among educators and men of science as to what science should be taught in the school and how it should be taught. Even the quasi official report of the member representing science on the Committee of the N. E. A. states that physiography is not a fundamental disciplinary study, calls the study of natural history sham biology, and says that neither physiography nor biology can be studied without previous training in physics and chemistry. But we think that partial points of view will supplement each other as the subject is discussed in journals and in meetings such as that of the department of Natural Science Instruction of the N. E. A., and that of the recently organized New York State Science Teachers' Association. We believe that courses can be arranged extending from the kindergarten to the college that will not only supply the student with information of enduring practical value, but will also give him a training and a culture not otherwise attainable.

The most serious obstacle in the way of science in college entrance examinations is, however, tradition, and this is an obstacle that consumes itself. For centuries the classics were a necessity and there was no science. A certain amount of conservatism is always desirable ; we want growth rather than revolution. It is probable, however, that there are some college presidents who do not know that at Cambridge University most of the students take the B. A. degree without studying a word of Latin or Greek at the University. We believe that the survival of the fittest is the best method of development. We do not ask that science be required in entrance examinations neither do we wish to see classical studies excluded, but we think it reasonable that science and classics should be treated with equal fairness.

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*THE AIM OF PHYSICAL CHEMISTRY.**

A PAPER bearing the above title was read by Prof. Nernst at the opening of the new laboratory for physical chemistry and electro-chemistry at the University of Göttingen, on the second of June last. This is the third chair that Germany has devoted to the study of that region, which lies intermediate between physics and chemistry. First, in point of time must be mentioned that of Landolt in Berlin, while the laboratory of Ostwald, in Leipsic, is more directly connected with the newer developments in that field which has been systematized into a distinct science largely by Ostwald himself. Indeed, much of the best work of Arrhenius and Nernst was done while they were associated with Ostwald, so that the title 'Leipsic school,' has come to have a definite significance. It is now well known that Leipsic will soon be provided with a physico-chemical building and equipment which, in point of completeness, will have no rival.

The new structure in Göttingen has been erected to meet the growing demands of physical chemistry in that university, under the guidance of Prof. Nernst. At the formal opening there were present such men as Arrhenius, Beckmann, Borschers, van't Hoff and others. Ostwald and Landolt were prevented from attending. The following are some of the more important points which were brought out by Nernst on that occasion.

To-day we are furnished with new evidence that an intimate reunion is being effected between two branches of science

*Published by Vanderhoeck and Ruprecht. Göttingen, 1896.

which have become separated. A reunion, since a separation, which does not date from a very early period, took place. Newton, the Father of modern physics, wished to apply his law of force to cosmic phenomena as well as to chemical. Even at the beginning of this century we find men like Dalton, Wollaston, Ampère, Davy, Dulong, Gay Lussac and others, who have simultaneously enriched both physics and chemistry. The separation came later and we recognize Weber, Helmholtz, Kirchhoff, Clausius, Fr. Neumann, Kundt, Hertz, as distinctly physicists, while Berzelius, Dumas, Liebig, Wöhler, Hofmann, are as distinctly chemists. It is also true that there were a few, contemporary with the above named, whose work enriched both physics and chemistry, notably, Faraday, Hittorf, Horstmann, J. W. Gibbs and the cooperation of Kirchhoff and Bunsen, and Guldberg and Waage. But that a marked separation of physics from chemistry had taken place is beyond question.

The time at which this began to be pronounced was about the year 1835. A decided tendency to reunite was observed in the year 1885. It was at this latter date that van't Hoff's epoch-making work on solutions appeared, and in the same year Ostwald published the first volume of his *Lehrbuch*. Since that time the number of those who are at once physicists and chemists has greatly increased.

If we ask what is the difference between physics and chemistry it is generally replied that chemistry has to do with the composition and structure of the molecules, while physics deals with the molecules already made, but this distinction is founded on a special hypothesis, the atomic hypothesis, which cannot be regarded as a general principle on which to base such a division. If we state that physics investigates those natural phenomena in which the properties of matter remain unchanged, while chemistry studies the transformations of matter, the distinction does not always agree with the facts.

On the other hand, physics and chemistry have much in common which is distinctive. The other branches of natural science find the objects of their investigations existing in the external world. The zoologist, the physiologist, the astronomer, have their material already prepared for them. Their work is *descriptive*. The chemist and physicist prepare their own materials, and their science is *constructive*. But what is the real difference between physics and chemistry, which are taught in separate laboratories and by specialists in each branch? The distinction is one which is deeply imbedded in the mind of the investigator. He who would become a physicist must acquire a good mathematical training, while a chemist must be acquainted somewhat with mineralogy, physiology and botany. Further, it is difficult to preserve physical apparatus in the presence of the destructive fumes of the chemical laboratory, and consequently such apparatus is usually absent from, or in poor condition in, the chemical laboratory. For the same reason the physicist avoids the 'chemical kitchen' in his apartments. Thus the distinction which existed between physics and chemistry for a half-century (1835–1885) was a necessity and contributed largely to the advance of our knowledge of the natural sciences. And those same causes which have made the separation of physics from chemistry a necessity are still operative to some extent, so that no one thinks at the present day of combining the physical and chemical laboratories into one. But like two great nations which have been brought more closely together by common interests, physics and chemistry will have more and more points in common the further investigation is carried. Physical chemistry is the diplomatic agent to effect this. "If the physicists and the chemists work each in their own field and with their own methods, a large area between the two will remain untilled, viz., all that which can be cultivated only by the simultaneous application of both methods of work. That physical chemistry finds here an enormously large and fruitful field for activity is distinctly shown by the scientific advances of the last decade."

One may fairly ask why has this point of view presented itself for the first time, in the last few years? This is the answer: "*In the fifty years previously referred to, there were discovered a number of general natural laws, which were particularly important and useful because of their simplicity. These made it possible for the investigator to comprehend a very large number of facts in a few words or formulæ.*" It has thus become relatively easier for the physicist and chemist to know something of that science which belongs more directly to the other. In reality, such knowledge has become necessary on the part of both. The physicist cannot understand electrical phenomena and thermodynamics without a knowledge of the law of chemical mass action and an intelligent comprehension of purely chemical phenomena. The chemist, in turn, must have a fair knowledge of electricity in order to comprehend electro-chemical processes. Indeed the inter-relation of physics and chemistry has become so pronounced that a specialist in each can work over only a limited range without having to take the other into account. The remainder of this interesting address is devoted more particularly to a discussion of the nature of the work which it is proposed to carry on in the new laboratory in Göttingen.

In connection with what has already been accomplished by physical chemists since their branch has become a distinct science (which is hardly more than a decade), it seems desirable to call attention to some of the generalizations which have been reached by them; and what is so important in physics, and especially in chemistry, as a generalization, which brings together and interprets at least a few out of that chaos of facts whose real significance and meaning are for the most part unknown.

The generalization of van't Hoff that 'optical activity' is due to the presence of an asymmetric carbon atom, was the foundation for all the recent developments in stereochemistry in the hands of Wislicenus, Hantzsch, Werner, V. Meyer, Auwers and others. His application of the gas laws to solutions, and its counterpart, the Arrhenius theory of electrolytic dissociation, have a significance the breadth and depth of which are just beginning to become apparent. Further, his studies in chemical dynamics, though less known, are probably his greatest achievements. The work of Ostwald is of too general a character to specify details. We owe to him preeminently the systematic classification, into a science, of those facts which it required a century to ascertain. Scarcely less interesting are the theoretical deductions of Nernst, who has pointed out the real source of the electromotive force in Voltaic and other elements, so clearly and correctly that our ideas in regard to primary batteries have been largely revolutionized since the appearance of his well known paper in 1889. From the theoretical side we must not forget the application of thermodynamics to physics and chemistry by Horstmann and J. W. Gibbs, and the wide significance of the law of Mass Action, even should they date from a slightly earlier time. And hardly less important than the theoretical advances which we owe already to physical chemistry are the experimental. One need mention only the work of Raoult and Beckmann on freezing points and vapor tensions, of Le Blanc on polarization, of Ramsay and Shields on surface tension, or of Ostwald on conductivity, to verify this statement.

If in so short a time such advances have been made, it seems reasonable to expect much from work in this very imperfectly explored field, which belongs neither to physics nor chemistry, but is a distinct region, lying between these two, and employs, in addition to its own, some of the theoretical and experimental methods belonging to both.

HARRY C. JONES.
CHEMICAL LABORATORY,
JOHNS HOPKINS UNIVERSITY.

TAPIRS PAST AND PRESENT.

AN important contribution to our knowledge of the structure and origin of the tapirs has recently been made by Mr. J. B. Hatcher,* of Princeton University. The distribution of the recent tapirs remained an enigma until the discoveries by paleontologists solved the problem. We now know that in former geological epochs, and as early as the Oligocene, the true tapirs were generally distributed over the northern hemisphere of both continents, and that probably owing to geographical and climatic changes the present tapirs were stranded as it were in two widely separated areas of the the globe, that is to say, in the Malay Archipelago and in South America.

In a number of the mammalian orders, there are types of great interest to the morphologist, which are called generalized or collective types. These forms include many characters in their structure which are primitive, and they are of great assistance in unravelling the phylogenetic history of the mammalia. The tapir is such a generalized member of the perissodactyle division of the ungulates, and it represents in a certain degree, especially in the structure of the feet, the ancestral type from which arose all the modern odd-toed ungulates.

* Recent and Fossil Tapirs, by J. B. Hatcher, Am. Jour. Sci., March, 1896.

It is surprising how little change the tapir has undergone since the Oligocene, and the genus *Protapirus* based upon the dental characters alone can hardly be separated generically from the recent tapir. The structure of the skull in *Protapirus* is decidedly more primitive than that of any of the living tapirs. In *Protapirus validus*, of the White River Oligocene of the United States, the skull is elongated and compressed, in contrast with recent species the nasals project farther forward, and consequently the proboscis in this ancient tapir was probably much smaller than in recent forms. The shape of the nasal bones is quite different from that of recent tapirs, as in these the nasals are deeply excavated proximally into fossæ which lodge the large air sinuses. In *Protapirus*, however, these fossæ are represented by two long and narrow grooves, one on each side of the nasals, and these grooves extend farther forward on the skull than in the living tapirs.

In *Protapirus validus* the cranial portion of the skull is much elongated and the sagittal crest is prominent; on the other hand, the postglenoid and paroccipital processes are united and close the external auditory meatus inferiorly. This is decidedly a specialized character of *Protapirus* and is not found in the skull of any of the existing tapirs. In comparing the recent with the fossil tapirs Mr. Hatcher finds that the skull of *Tapirus roulini* (Syn. *T. pinchacus*) more closely resembles that of the fossil *Protapirus validus* than any other of the living tapirs. *Tapirus roulini* is rather aberrant in its distribution, as it is found in the high latitudes of the Andes. The osteology of this species has been very fully described by Döderlein.*

I see no use in reviving the generic name *Elasmognathus* Gill. The ossification of the mesethmoid in this form is not considered

* Über das skelet des Tapirus Pinchacus, Inaugural Dissertation, Bonn, 1877.