imaginary world, which might vary and so create in the same way a change in all the laws?

Poincaré found something analogous to this, at any rate, in the ideas now being brought forward on the subject of mechanics, and which were later in the congress put forward by Prof. Langevin, whose name is known in connection with work in radio-activity. It is now asserted that the laws of mechanics, once considered absolute, are not so. They must be changed, or at least enlarged. They are only approximately true for the velocities to which we are accustomed, and cease to be so for velocities comparable to that of light. One might say that, as a result of the constant dissipation of energy, the speed of bodies has much diminished, since their activity gets transformed into heat. Thus remounting back to the past, one would find an epoch when velocities comparable to that of light were not uncommon, and when, as a consequence, the classical laws of dynamics were not true. But if, on the other hand, we consider these laws as only approximate laws, and consider the laws of motion of molecules as the true laws, we can keep our faith in the immutability of laws in general. There is not, then, a sole law that we can enunciate with the certainty that it has always been true in the past. Nevertheless, there is nothing to hinder the man of science from keeping his faith in the principle of immutability, since no law can descend to the level of a secondary law without being replaced by another law more general and more comprehensive.

Prof. Durkheim, the celebrated sociologist, examined the question of "judgments of value" and social ideals. How do they arise? They cannot be accounted for on utilitarian principles, for they are often in direct conflict, not only with individual, but even with collective utility. They assert values which go beyond the practical. Must we, then, assume that the ideal is of a different nature from the world of fact. By no means. The ideal values are created in periods of great excitement, such as, for instance, the Renaissance and the French Revolution, when life for a time turns aside from the merely useful. Whilst the intenser life of such periods must of necessity soon die down, the judgments of value and the ideals they create survive into the periods of greater tranquillity, and it is from this that the apparent contradiction between the ideal and world of fact is born.

Prof. Ostwald, the exponent of "energetics," put forward a curious hypothesis in his paper "La Volonté et sa base physique" on the connection between the second law of thermodynamics and the mental phenomena of will. He started from general considerations drawn from Comté's and his own classification of the sciences. The notion of the antecedent and more general sciences finds a regular and systematic application in the subsequent and more special ones, while at the same time these latter require, in addition, the use of new conceptions. There is, for example, a mathematic and a geometry of chemistry, but not a chemistry of mathematics or a biology of physics. He then examined in this light the conception of energy. It appears for the first time in the domain of the physical sciences, and for that reason, while it has no application in the more general sciences of mathematics and logic, it should play an auxiliary part in biology, psychology, and sociology. The laws of the lower sciences cannot adequately explain the phenomena dealt with by the higher, but they provide the framework inside which the latter must work. How does this work out in detail? What meaning have the laws of energy applied to mental life? Just this—that whatever else mental life is, it has to work inside the limits of the second law of thermodynamics. Each individual is occupied all its life with the task of making circulate through its own body a part of the general course of "free" energy on its way to energy of a lower intensity; and further, as only part of this energy can be usefully employed, the rest being wasted in heat, so whatever else mental life may be it must first be directed towards getting as much out of this dissipation as possible. In the effort to increase this percentage, to save energy, comes, in Ostwald's opinion, the whole phenomena of the will. He does not pretend that the second law is an adequate explanation of all mental process, but it is the conditioning framework inside which all the rest must work. It is the dominating fast of mental life. It is this which makes the tremendous importance of the will. All human activity is devoted to get the most out of this limited energy. (Incidentally, one may note the resemblance to Mach's conception of science as a process of economy of thought.) It is this conception of the "degradation of energy" which forms the basis of all the processes in which Schopenhauer saw manifestations of the fundamental will.

The English element at the congress was very small, being responsible for only eleven papers out of a total of 200. Among these the most important was Dr. Schiller's paper on error, which provoked, as any exposition of pragmatism always does at these meetings, a most lively discussion. There was also a paper by E. S. Russell on vitalism, and an interesting little note by Miss Constance Jones sketching out a new law of thought, which attempted to lead logic out of the barrenness of the law of identity, and which she enunciated in the phrase: "Every subject of predication is an identity (of denotation) in diversity (of intension)."

The next congress will be held in London in 1915, under the auspices of the University, and it is hoped that this will create a greater interest in these meetings than has heretofore been the case in this country.

RESEARCH AT THE NATIONAL PHYSICAL LABORATORY.[1]

THE representative character of the work done at the National Physical Laboratory is well shown by the eight papers in the volume before us.

Nos. 1 and 2 are by Dr. Chree, and are entitled "Some Phenomena of Magnetic Disturbances at Kew" and "Discussion of Results Obtained at Kew Observatory with an Elster and Geitel Electrical Dissipation Apparatus from 1907–9."

No. 3 is the ninth report to the Alloys Research Committee of the Institution of Mechanical Engineers, on "The Properties of Some Alloys of Copper, Aluminium, and Manganese," by Messrs. Rosenhain and Lantsberry. This is a voluminous paper, and occupies more than half of the entire volume. It is the direct outcome of the eighth alloys research report on the properties of the alloys of copper and aluminium. The study of any ternary system of alloys is a work of considerable magnitude. As the authors remark (p. 65), "If we suppose for the sake of comparison that the study of alloys to the extent of one for every range of 2 per cent. in composition constitutes a sufficiently complete investigation of any system, then in any series of alloys of two metals, such as copper and aluminium, the study of some fifty alloys would meet these requirements, while the corresponding degree of completeness in the case of a ternary system would require the study of no less than 1250 alloys." Very few industrial alloys, however, belong, strictly speaking, to a binary system. The majority are ternary, or even more complicated mixtures, and it is therefore of great industrial importance as well as of scientific interest that the study of such systems as the above should be undertaken.

The authors have not attempted to cover the entire field, but have contented themselves with experimenting on the addition of manganese to the most promising binary mixtures revealed in the eighth alloys report, which are situated at the ends of the system.

At the copper end they have found that certain ternary alloys present advantages over the best binary alloys, these consisting chiefly in a "higher yield point . . . a slightly higher ultimate stress and an undiminished ductility," in the static tests. A hot-rolled bar of a bronze containing approximately 10 per cent. of aluminium and 1 per cent. of manganese gave an ultimate stress of 42 tons per square inch with 30 per cent. elongation. In the dynamic tests, however, there is very little to choose between the binary and ternary systems. Three alloys were found to offer remarkable resistance to abrasion, and in this respect considerably surpassed ordinary tool steel, and as they machine quite readily they might very well be tried in cases where this property is of primary importance, *e.g.* in the form of turbine blades which have to withstand high velocity steam. As regards constitution, the authors have found that

[1] The National Physical Laboratory: Collected Researches, Vol. VII. 1911, pp. iii + 228.

" within the limits of the alloys studied, the constitution of the ternary alloys very closely resembles that of the binary alloys of aluminium and copper; manganese influences the properties of the alloys in a manner somewhat similar to that of aluminium, but at a different rate."

At the aluminium end the results have been less favourable. The most promising alloy appears to be one with 3 per cent. of copper and 1 per cent. of manganese, which in the form of a chill casting gave a tensile strength of 12 tons per square inch and an elongation of 13·5 per cent. on 2 inches. In the form of rolled bars, however, the authors say, " there does not appear to be any advantage in using the ternary alloys as compared with the alloys of aluminium with copper alone."

The remaining papers are as follows:—

(4) " Report on the Progress of the National Experimental Tank," by Dr. R. T. Glazebrook.

(5) " On the use of Mutual Inductometers," by A. Campbell.

(6) " Comparative Life Tests on Glow Lamps," by C. C. Paterson and E. H. Rayner.

(7) " On a Method of Counting the Rulings of a Diffraction Grating," by G. W. Kaye.

(8) " The Expansion and Thermal Hysteresis of Fused Silica," by G. W. Kaye.

In view of the extensive application of fused silica or quartz glass to physical and chemical operations, the last-named paper is of considerable interest. A curve is given from which the mean coefficient of expansion over any desired range between $-190°$ C. and $1100°$ C. may be derived. From this curve it appears that two change-points exist, one at $-80°$ C., the other at about $1000°$ C. As regards linear hysteresis, the author concludes, " Silica over a range of $0°$ C. to $400°$ C. has nothing to fear in comparison with either Invar or Jena thermometry glasses. . . . There is practically nothing to choose between the different kinds of fused silica." A silica standard metre is being completed at the laboratory.

H. C. H. C.

SPECIALISATION IN UNIVERSITY EDUCATION.

THE March issue of *The Johns Hopkins University Circular* contains an account of the celebrations in connection with the Commemoration Day of the University held on February 22. Dr. James Bryce, the British Ambassador to the United States, was the principal speaker, and in his address discussed the tendency to over-specialisation in university education. Mr. R. Brent Keyser, the president of the Board of Trustees, read a statement of the plans for the development of the new site for the University. Nine years ago, he said, at the time of the raising of the Million Dollar Endowment Fund of 1902, the University received also the gift of the Homewood property. This property, under the deed of gift, is to become the permanent home of the University when, in the judgment of the Board of Trustees, the interest and welfare of the University permit. A plan for development has been provided which will admit of growth and alteration to suit the changing needs of future years. To-day we have been given, he continued, means to accept the offer of 50,000*l.* from the General Education Board, and the total amount pledged, part of it already paid in, amounts to nearly 240,000*l.* With great wisdom, the General Education Board, the aim of which is to help the cause of education of the whole country, has provided that at least 100,000*l.* of this amount shall be retained as a permanent endowment, the income only to be used, so that the institution might not be crippled in its real work by the expenditures incident to large building operations, and by the greatly increased expense which will come from living in such an enlarged environment.

Mr. B. H. Griswold, jun., chairman of the committee on the endowment and extension fund of 1910, said 1500 gifts, ranging from one dollar to 20,000*l.*, totalling nearly 240,000*l.*, and substantially every dollar of it from Maryland, with the exception of the gift of the General Education Board and contributions of non-resident alumni, had been secured. Apart from the original gift of the founder and apart from all legacies, the citizens of Maryland and the alumni of the University, before the last appeal was made and answered, had bestowed, by direct gift, upon the University since its foundation more than 600,000*l.* The exact amount contributed to date to the 1910 Endowment and Extension Fund is 238,635*l.* Of this sum, 50,000*l.* was given by the General Education Board, 48,000*l.* by the trustees of the University, 60,000*l.* was subscribed by the alumni, and the balance of more than 80,000*l.* was given by those to whom we have given the simple but honourable degree of " Friends of the University." A few special gifts may be mentioned: there is one of 4000*l.* to the department of romance languages, one of 2000*l.* for the Edmund Law Rogers fellowship, and 2000*l.* for the Hutzler library.

Mr. Bryce's address applies equally to British as to American universities, and it is here reprinted in an abridged form.

A remarkable feature of the thirty-five years over which we look back is the wonderful development of the various departments of human knowledge, and especially those which are concerned with the sciences of nature, into special branches, each of which has been tending to become more distinct from the others. So far from finding ourselves approaching the end of human knowledge, we find that the more we know the more remains beyond to be known, and that the realm of the unknown seems to be always increasing with every addition to our knowledge. It is as though the path which we are following were always diverging into a number of different paths which tend to separate from one another, and lead us into untrodden solitudes to which we see no end. Within the recollection of most of us, new branches of science have made good their place, and have become recognised as separate fields of inquiry, and along with this it has befallen that the great majority of scientific inquirers now, so soon as their general scientific education has been completed, begin to devote themselves to one particular branch of investigation and throw their whole energy into pushing it forward. A man is now not a " natural philosopher " in the old sense of the term, but belongs to some one of the specific branches into which natural philosophy has become divided. The same thing has happened in those practical arts which depend upon the application of science. They, too, have multiplied by division, and thus new practical professions have grown up, which were scarcely thought of forty years ago.

The same thing has of necessity happened in university education. We have now in all organised universities professors of a large number of distinct branches of knowledge, which were formerly lumped together as being one branch under one professor.

So also among the students the tendency is for those who have advanced some way to begin to devote themselves to one particular line of study and investigation. Both the teacher and the student are naturally fascinated by the prospect of discovery. The professor likes best to lecture upon the subject in which he is pushing forward his own investigations, and the student is able to find in them the most attractive field of experimental research.

This sort of specialisation has become inevitable, but there is a consequence attached to it which has seemed almost equally inevitable, namely, that part of the time which was previously given to general study, to a knowledge both of natural science in general and of other subjects, has now had to be devoted to this special study. The field of nature is unlimited. Human curiosity is unlimited. But human life and the capacity for using our time and our powers in the acquisition of knowledge remain within very narrow bounds.

Accordingly, the problem which to-day confronts us in all universities is how to find time both for these specialised studies, which have become so much more absorbing, and also for a survey and comprehension of the general field of human knowledge which is necessary in order to make the university graduate a truly educated and cultivated man, capable of seeing the relations of his own particular study to others and of appreciating the various methods by which discovery is prosecuted. This problem of reconciling special with general study, although most urgent in the sciences of nature, shows itself in what may be called the human subjects also.

However, the difficulty I am referring to arises chiefly