the State. But ninety-nine per cent. of the difficulty will disappear if only the university will do the work admirably and let others take the credit. If the purpose be to promote public welfare why should one care who gets the praise? In every instance, hitherto, in the writer's experience, the scientific, philanthropic and statistical departments of the State and the nation have been eager for cooperation, wherever the university has demonstrated ability to do work superbly, and in most cases they have supplied the money. Besides, it is one thing to appoint commissions and quite another to induce them to fulfill strenuously the purposes for which they were appointed. Many a yawning gap of deficiency in public officials may be quietly bridged by the patriotism and skill of the university, which should be the eye of the people, searching in every direction for opportunities to serve their welfare.

Will not the discussion of social and civil questions embroil the university in partisan politics? The most important problems of sociology and politics are not often embodied in State platforms, which usually consist of the national structure with a few more planks lauding one party and vilifying the other.

Do you ask where the money for all this is to come from? False to the core is the idea that the resources of a university are solely for instruction on its campus. The administration has no right to wait always on needed investigations for special appropriations from the Legislature. It should rather assume that in part the income must be consecrated, as need arises, to promoting the public good wherever it can be reached by scientific skill. Ultimately no use of money will pay better, even as an investment of capital. At last, we are not required to do more than our resources permit. It is the spirit that maketh alive. The important thing is for the university to construe its functions liberally and to choose intelligently what can be done now and what should be postponed. Time as well as money is necessary for perfect performance of its whole function.

In conclusion, let me say that the State University, founded by the Federal Government and supported by a mill tax upon the property of a great commonwealth, with broad outlook and intense devotion to the welfare of the people, can be made the best institution yet devised by the wit of man for the promotion of human progress. University mottoes are sometimes inspiring, but the one that appeals to the writer most is from Cicero, De Legibus—'Salus Populi Suprema Lex.' The welfare (salus), construed broadly, is coextensive with public interests, which, beginning in the soil of earth and rising through human society, mount upwards finally to the Kingdom of Heaven.

R. H. JESSE.

SCIENTIFIC BOOKS.

Le système métrique des poids et mesures. Par G. BIGOURDAN. Paris, Gauthier-Villars. 1901.

A hundred years have passed since the inauguration of one of the most important reforms yet undertaken by civilized man, considered as to its far-reaching effects upon social, economic and scientific interests and conditions. Although the establishment of a universal and uniform system of weights and measures among all enlightened nations is not yet an accomplished fact, that most desirable end is so nearly reached that no reasonable person can for a moment entertain a doubt as to the final result. Only two great nations, constituting the English-speaking people of the world, still hold out against the irresistible movement in favor of uniformity of standards and they are both wavering very decidedly, preparatory to the inevitable yielding which the most thoughtful of their people are endeavoring to hasten. During the last decade in both England and America popular interest in the subject of

metrological reform has been unprecedentedly great and there is a general conviction that abandonment of the antiquated, inconvenient and unscientific systems of measure now in use must soon become an absolute necessity.

Under these conditions the excellent treatise of M. Bigourdan is a most timely and welcome contribution to available literature relating to the history of the origin and the gradual propagation of the metric system of weights and measures. In its preparation the author has had the advantage of convenient reference to original papers, state, scientific and personal, and in his résumé of the very important operations of the last quarter of a century, as embodied in the work of the International Bureau of Weights and Measures, he has been able to avail himself of the thorough knowledge of Messrs. Benoit and Guillaume, the two distinguished experts of that bureau.

The book begins with a brief discussion of the chaotic state of all matters relating to standards of measure during a few centuries preceding the coming of the metric system, in which little is said of anything outside of France. At a very early period in the history of metrology attempts were made to establish natural standards—that is, to refer ordinary standards of measure to something in nature fixed and unchangeable. It was not until 1670, however, that a really rational and scientific scheme was proposed by Gabriel Mouton, vicar of the Church of St. Paul in Lyons.

A few years earlier than this it had been proposed to refer the standard of length to the pendulum making a single vibration in one second or in some fraction of a second. Perhaps this suggestion came first from Sir Christopher Wrenn, and it was made about 1670–73 by Picard and by Huyghens. Mouton's system was *in principle* the metric system of to-day; he proposed to refer the standard of length to an arc of the terrestrial meridian; his multiples and submultiples of the unit were decimal, and he also proposed for convenience of reproduction a reference to the seconds pendulum. It is interesting to note that when Picard proposed the seconds pendulum as a standard of length in 1671, he expressed a suspicion that such a pendulum must be somewhat shorter near the equator than near the pole, although it was only in that same year that Richer went to South America to make a series of astronomical observations, during which this fact was actually proved.

During the next hundred years many suggestions looking to a reformation of standards were made in France and many projects drawn up to bring about a unification of weights and measures throughout the nation, but it was not until one was presented by Talleyrand, about 1789, that the real movement set in. In this project he advocates the use of the pendulum as a standard of length, and with evident appreciation of the importance of the matter with which he is dealing, he suggests a reference of the subject to a joint international commission, to be composed of an equal number of members of the French Academy of Sciences and of Fellows of the Royal Society of London. At about the same time an active agitation in favor of metrological reform began in England and also in the United States, its chief exponent in our own country being Thomas Jefferson. Unhappily neither of these movements came to much, for reasons that cannot here be gone into. The history of the creation of the metric system and its adoption by the French Government, which followed within a few years after Talleyrand's project was submitted, is pretty well known to those interested in this phase of the subject, and the details of it constitute the larger part of the volume under review.

The whole subject was in the beginning referred to a Commission which, with those that were subsequently appointed, fortunately included such men as Laplace, Lagrange, Borda, Mongé, Condorcet, Lavoisier, Delambre, Coulomb, Cassini and others, constituting a most brilliant array of Frenchmen most eminent in science.

Consideration was given to three 'natural' standards to which the unit of length might be referred: The length of a pendulum beating seconds, the quarter of the terrestrial equator and the quarter of the terrestrial meridian. The pendulum was rejected, principally because its use involved the elements time and force, both foreign to length; the equator was rejected because of the difficulty of measuring it, climatic

and other conditions rendering it relatively somewhat inaccessible; and the quarter of a terrestrial meridian was finally adopted. It is pleasing to note that throughout the discussion which led to this result, the influential members of the Commission, as well as many others not members, stood out against the use of any unit of length or mass already in use in France, as it was recognized that such use would be an obstacle to the introduction of the system among the people of other nations. An interesting episode of the initiative of the arc measurement was a controversy over the use of a sector in the determination of latitude or the newly invented repeating circle of Borda. Indeed it seems not unlikely that 'a desire to make the reputation of the circle of Borda' had some influence in the choice of the new standard as against the seconds pendulum. Delambre proposed to Borda to employ both sector and circle, but the latter dryly intimated that it was desired to ascertain if the sectors were good, and the matter was not pressed.

When the Commission was received by the King, Louis XVI., after its recommendations had been approved and before the formal beginning of its operations, his majesty, speaking to each one in turn of the special duties that had been assigned to him, asked Cassini (the fourth eminent astronomer bearing that name), to whom had been assigned the triangulation and measurement of latitudes, how it was that he was going to remeasure an arc of the meridian that his father and grandfather had already done before him. Did he hope to do better than they? To which Cassini replied that he would not so flatter himself, if he had not a great advantage over them in the fact that while the instruments which they used in measuring angles gave results correct to within fifteen seconds, that invented by Borda would enable him to reach a precision of one second.

M. Bigourdan's volume contains much detailed information relating to the work of the Commissions, with many interesting and important citations from original documents. The fundamental legislation by which the system was founded is fully discussed, the opposition to it is fairly presented, and the subsequent legislation and discussion leading to its final adoption by the nation as a whole receive satisfactory treatment. There is a chapter on the propagation of the system among foreign nations which leads up to the appointment of an international metric commission about 1870, and to the establishment of the International Bureau of Weights and Measures about 1875. The splendid work of the latter during the twenty-five years of its activity is treated in some detail and forms a fitting close to a most useful and interesting contribution to the history of metrology.

T. C. MENDENHALL.

A Treatise on Electromagnetic Phenomena and on the Compass and its Deviations Aboard Ship, Mathematical, Theoretical and Practical. By Commander T. A. LYONS, U. S. Navy. John Wiley & Sons.

The first volume of this treatise, the only one yet published, deals with electromagnetic phenomena, or radiation in all its protean forms. If the reader wants information about sun-spots or auroræ, about Crookes's fourth state of matter or Bjerknes's imitations of magnetic fields by pulsating discs, about the work of Hertz or the genesis and action of Röntgen rays, he will find it in this introductory volume. However many and however diverse the subjects discussed, they are all treated from the point of view of the wave-theory. Commander Lyons seems to hold a brief for the ether whose existence he seeks to remove from the condition of a working hypothesis and whose properties he tries very hard to define. This is indeed a difficult task; for he tells us, on page 9, that "the mathematician attributes to the ether properties necessary to the formation of equations expressing its energy; the physicist ascribes to it qualities essential to the explanation of facts; the electrician meets conditions that require further hypotheses; still others do not accept fully any one of these conceptions; and some even reject the ether altogether."

So conscious is the author of the paramount importance in physics and philosophical speculation of the medium which fills intermolecular as well as interstellar space, that he dwells with great insistence upon the experimental evidence which there is for its existence. He is so eager