

They then commence the preparatory course, which occupies, on the average, not less than three sessions, for, although 22 per cent. of the students complete preparatory courses in two sessions, 45 per cent. take three sessions, 27 per cent. four sessions, and 4 per cent. five sessions. This preparatory course comprises mathematics, chemistry, mechanics, and physics, as well as modern languages; it extends over about seven months in each year, and the course is repeated year by year. M. Pelletan thinks that to make a student follow the same course for an average of three years must frequently tend to make him rather stupid. According to him, the course in mathematics is much too theoretical in its character; the students spend too much time on analytical geometry; they deal too much with abstractions and too little with problems involving realities and actual numbers; as a result, their attempts to apply the mathematics they have learned lead to results, not only false, but actually absurd.

When the student has completed his preparatory course he spends two years on the more advanced courses, making a total of five years' study. A very large part of his time is devoted to higher mathematics, as is shown by the fact that about 36 per cent. of the marks awarded for purposes of classification are given to this subject, while mechanics and machinery receive about 26 per cent., physics about 21 per cent., chemistry about 20 per cent., astronomy (!) about 9 per cent., architecture about 2 per cent., history and literature about 4 per cent., German about 4 per cent., drawing about 5 per cent., and military subjects about 5 per cent. According to M. Pelletan, a large part of the mathematical course is simply a repetition of the work done before.

The amount of time spent on practical work is absurdly small; none is mentioned in the case of mechanics and machinery; only six lessons are given in physics and eleven in chemistry; on the other hand, the physical welfare of the students is treated more seriously, for they receive eighty lessons in horsemanship, sixty-four in gymnastics, forty in fencing, and sixteen in boxing.

Students are allowed little liberty; they are under military discipline, have little leisure, and are required to spend a considerable time in drill, &c.

According to M. Pelletan, the result of this is that the most mediocre students, provided they are gifted with a good memory, come out first in the list and receive the best positions; in all that concerns "red tape" they are perfect, but they lack initiative, for they have never been allowed to think or do for themselves.

It is not for a foreigner to criticise French methods, many of which, as the writer well knows, are admirable, but if the premier engineering school of France is conducted on the principles set forth in this paper, there is certainly ample room for that reform which the author demands. The present writer has ventured to suggest to the director of the Ecole polytechnique that a reply should be made to this indictment of his institution.

J. WERTHEIMER.

REFRIGERATION.¹

A SHORT account of the first International Congress on Refrigeration appeared in NATURE of October 2, 1908, and served to indicate the important position which refrigeration has taken in the fields of technics and commerce.

The bulky volumes before us, in which communications appear in their original French, English, German, or Italian, fully confirm that view. The subjects discussed range from magneto-optic investigations on liquid hydrogen, through the preparation of cooling agents to the law of the transport of chilled food; from the use of liquid air in mining to its use for increasing the efflorescence of bulbs.

These 200 communications vary very much in character. Some are *résumés* of well-known work at low temperatures, others compilations by authors who appear to have been ignorant of the work of others in the field, and to have thought it necessary to fill their papers with elementary transcriptions from text-books.

¹ Premier Congrès international du Froid, Paris, Octobre 5-12, 1908. Tome I., Comptes rendus, pp. iv+700. Tomes II. and III., Rapports et Communications. Vol. II., pp. iv+1009+ii; vol. III., pp. iv+963+ii; illustrated. (Paris: Secrétariat-Général de l'Association du Froid; London: 3 Oxford Court, Cannon Street, n.d.) Price, 3 vols., 25s.

The vast majority, however, are new and valuable additions to the subject. Many are the results of prolonged and careful experimental research on questions such as the industrial separation of oxygen and nitrogen from the air, the specific heat of certain salt solutions, the conductivity of insulators under experimental and under practical conditions, and both relatively and absolutely. Naturally much attention was paid to the preservation of food of all kinds, both on land and at sea. In this connection the particularly complete investigations from America on the physiological effect of cold storage for varying times and at varying temperatures on poultry are specially noticeable. This paper is accompanied by really beautiful photographs of sections, and quite disposes of the notion that cold storage has any bad effect on nutritive values if maintained at the proper temperature and followed by careful thawing in dry air. Many other communications discuss the same question less exhaustively with regard to other food materials. In this connection it is noticeable that, on the whole, the standard of the English papers was below that reached by those from the other great countries. Happily, this defect was to a large extent made up by the colonial communications; but this does not fully atone for the want of any official notice of the congress by the Boards of Trade and Agriculture. The difference is particularly marked with reference to America, and is only an indication of the want of interest these departments take in the fields which they are supposed to represent. Another question which appears in several communications in various forms is that of suitable units for the refrigerating industry. It is extremely desirable that some agreement should be arrived at which would be internationally acceptable. As a result of these deliberations an international bureau has been formed, which has come to some agreement, and which will submit recommendations to the next congress at Vienna in October, 1910.

FRANCIS HYNDMAN.

UNIVERSITIES AND TECHNICAL TRAINING.¹

PERHAPS the most noteworthy educational event of modern times was the origin and development of the Universities of Berlin and Bonn. After the Battle of Jena and the humiliating Treaty of Tilsit, after the closing of the University of Halle by Napoleon, at a time when Prussia had sunk under the heel of Bonaparte to the rank of scarcely a third-rate Power, the King, influenced chiefly by the brothers Wilhelm and Alexander von Humboldt, determined to look to higher education as a means of retrieving his country's fortunes. Such was, and still is, the faith across the Rhine in the practical value of education to the State. Napoleon got his Treaty of Tilsit, but there were men by the side of the Prussian King with great ideas, men who with stern and far-seeing determination forged weapons which, during the hundred years which have passed since then, in the field, in the laboratory, and in the *Seminar*, have made Prussia, have made Germany, what they are to-day.

The mediæval university as it developed in England held residence, in the sense of actual living together in seclusion, as an essential condition of study. The modern university, following the almost universal practice, required residence indeed, but residence only in the sense of working and thinking together, in science in the laboratory, in literature and philosophy in the *Seminar*. The faculties of the mediæval university were retained—*theology, law, medicine, and philosophy—music and other technical subjects were left outside to the care of special schools.* The mediæval university, as we have seen, had behind it the accumulated prestige of centuries; the modern university had no such individual advantage; it built upon the common educational history of mankind, and adapted itself with the greatest freedom to the requirements of the time. There is much wisdom in the saying that a university is born old. The mediæval university was a centre of dogmatic teaching; research, if not explicitly discouraged, was practically discouraged by the fact that general culture, the training of the judgment, was aimed at, not specialised learning; a recent Cambridge writer puts the object as "not how to keep our trade, but how to keep our souls

¹ From a lecture delivered before the Royal Dublin Society on March 9 by Prof. A. Senior.