When the periods consist of similar groups, as

222, 222;
123, 123;
333, 777, 444;
333555, 333555;
5174, 1399, 1399, 5174;

divisibility by the formula $S - S_1$ may be determined by inspection, and this conclusion will not be modified by like permutations of each group. Thus 123123, 312312, 132132 &c. are each divisible by 7, 11, 13, 91, 143 &c.

Lastly, since r_n changes with every value of δ, no general formula for the determination of primes can exist.

HENRY T. BURGESS.

Tarporley, West Norwood, October 16.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.[1]

IT is difficult to know how best to review a volume consisting of such varied matter as the Report of the Proceedings of an Educational Congress. Even when restricted to technical education, the subjects that may be legitimately discussed are very numerous; and with the constant widening of the definition, it is not easy to exclude any branch of knowledge, as outside the field of inquiry. After reading very carefully the closely-printed volume of nearly 300 pages, which includes the papers *in extenso*, and a summary of the discussions, we must own to some feeling of disappointment at the poverty of the results. Several of the writers and speakers are men of knowledge and experience, who write and speak with authority on their respective subjects; but, nevertheless, the volume before us adds little to what was previously known, and we look in vain through its pages for any new light to guide us in solving problems that are still imperfectly understood. The papers are, of course, of unequal merit, and we propose briefly to call attention to a few only, selecting rather those the authors of which show themselves abreast of the difficulties to be overcome.

The Congress was the fourth of its kind, the two previous meetings having been held in Bordeaux, in the years 1886 and 1895, and the first in Brussels in 1880. The latest Congress, held in London, was organised by the Society of Arts—a society which has always shown a deep and very active interest in technical education. It occupied four days from June 15, when M. Leo Saignat and the Duke of Devonshire delivered short introductory addresses, till Friday, June 18, when it was brought to a close by a few words of thanks from the chairman, Sir Owen Tudor Burne, to those who had assisted.

It is not easy to correctly group the contributions under separate headings. Several papers were descriptive of the methods and conditions of education in the countries and districts with which the authors were familiar. Some few treated of educational problems, and these were perhaps of widest interest. The vexed question of the organisation of instruction and of examinations was very fully discussed; a whole morning was devoted to papers bearing upon the teaching of domestic science; and a special feature of the Congress was the prominence given to the subject of commercial education.

Among the papers dealing with educational method, those on the teaching of chemistry were certainly the most informing. The character of the chemical teaching best adapted to the requirements of persons actually engaged in industrial pursuits, and also to school children preparing for such pursuits, had recently been the subject of a thoughtful report, prepared by a Committee specially appointed by the Technical Education Board of the London County Council. This report had been widely circulated, and both Dr. Witt, of Berlin, and Dr. Lunge, of Zürich, referred to it in their communications to the Congress. It is doubtful, however, whether either of these professors fully appreciated the problem, as it presents itself to organisers of evening classes in this country. Neither in Germany nor in Switzerland is there anything approaching to the teaching of technological chemistry, by means of evening lectures, to artisans. When Dr. Witt states, in his paper on the "Relation existing between the teaching of pure chemistry and applied chemistry," that he "cannot admit any fundamental difference in the methods of research," every one will agree with him; but when he says, "we want no schools for producing specialists," it may be reasonably thought that his generalisation is too far-reaching. There are successful dyeing schools in all parts of Europe, and he, himself, admits that "Dyeing, calico-printing, and paper-making are . . . industries which may rightly claim the necessity of some special instruction in the methods of manipulation," even if no other industries have like claims. Although Dr. Lunge, who is essentially a technologist, puts in a plea for the study of applied chemistry, his views do not differ essentially from those of Dr. Witt. He is at one with other chemical teachers in recognising the importance of training in the methods of research for all students. He says very truly: "Nothing in these times of ours is likely to turn out a first-class chemist, worthy of being later on put in charge of a large factory, who has not tried his hand at original research." Dr. Lunge insists, however, on the advantages of specialised training, and refers to the demand of Dr. Böttinger, head of a chemical factory, having under him a staff of more than one hundred chemists, for the establishment of more professorships of technological chemistry. It is, nevertheless, clear that the difference between the training in pure and applied chemistry which Dr. Lunge has in mind, consists mainly in the addition to the curriculum of technological students of a course of instruction in engineering, in order that they may advance beyond the position, to use his own words, of "testing slaves," to understand something of the processes of manufacture on a commercial scale. Dr. Lunge shares with most German chemists the opinion, that the knowledge of chemistry and technology that can be imparted to adults in night classes is useless from the manufacturer's point of view. He says: "I do not even think that apart from isolated exceptions, such knowledge is of much good to the foreman, whose duty it is to carry out instructions, and to see that the men do their work as prescribed by the staff." And, more definitely, he tells us, that "in Germany, even in those factories where the work is carried on with the greatest chemical refinement, the foreman and ordinary workmen are neither required nor even desired to know anything of chemistry." Dr. Lunge, in this statement, is, of course, referring to large chemical works in which there is a complete system of division of labour and sectional work, and where every difficulty, as it occurs, is at once submitted to some member of the large staff of chemists employed. But it is now generally admitted that there are many small trades in which a knowledge of chemistry is useful to the ordinary workman, and that the training, even when it proceeds from the process to the principle, may be made educationally valuable in supplementing the still imperfect, and too brief discipline of the elementary school. Prof. Armstrong's characteristic paper, indirectly bearing upon this subject, entitled "Heuristic instruction in physical science," was intended to show that the aim of sound science teaching should be to put learners in the attitude of discoverers; and there is no doubt that if such teaching were more general, the necessity for specialised instruction would be lessened, and a great part of the technical teaching of evening students might be remodelled. Dr. Armstrong scarcely did justice, however,

[1] Report of Proceedings of the Fourth Meeting, held in London, June 1897.

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to the good work now carried on in some of the London polytechnic institutions, which do not, as a fact, give any undue prominence in their teaching to the requirements of the Science and Art Department's examinations. Every one, however, will agree with him, that in the organisation of education some machinery must be found, whereby those, in whom the control of education is vested, are brought into contact "with those who are actively engaged in improving the methods of teaching, *i.e.* in educational research."

Of the papers dealing more particularly with technical education in relation to trade subjects, that of Mr. Sidney Wells, on the qualification of teachers, will be read with most interest. He recommends the attachment to trade classes, of student-teachers who would be required to follow a course of instruction covering two or three years. The students would be selected from the members of separate trades, and would be remunerated by scholarships for the loss incurred during the period of their training. The means of providing a suitable training for trade teachers is a serious question that must be faced before long. In many of our trade classes, as now conducted, there is a lamentable waste of energy and money owing to the want of previous education of those who *faute de mieux* are appointed as instructors A paper on "Theory and practice in trade teaching" deals with the same question from another point of view, showing the difficulties inherent in the teaching of trade subjects, as regards both the instruction to be given in the principles of science applicable to a particular trade, and the use of tools and machinery in workshop practice. In the discussion that followed the reading of these papers, and of others bearing incidentally upon the same subject, no serious attempt was made to grapple with the real difficulties of the problem. As might have been expected, there was considerable divergence of opinion as to whether technical instruction should be limited to the section of the trade in which the student is actually engaged, or should extend beyond it—a question which is unavoidably complicated by trades-union considerations. Mr. Steward, of the Central School of Arts and Crafts, in reference to the gold and silver trades, expressed his opposition to the system prevailing at the Vittoria Street School, Birmingham, where lads are encouraged to practise in the school other branches of the trade than the one at which they daily work. On the other hand, Prof. S. P. Thompson quoted with approval a passage from a report of the Technical Education Board to the effect, that at the Crafts School every effort was made "to give students a broader view and practice of the craft in which they are engaged"; and he exemplified his meaning by suggesting that silver chasers might be required to learn some other branch of the trade, such as engraving or enamelling. No fault can be found with many of the general principles enunciated in connection with trade teaching. That "all Technical Education Boards should negotiate with trade organisations with a view to co-operation"; that "technical education means a different thing in every trade or group of trades"; and that "all teachers of technical classes should be practical craftsmen," are propositions generally admitted. But, as regards teachers, we have already seen that the qualification of practical craftsmanship is not alone sufficient, and the difficulty arises in finding, united in the same person, the combination of qualities now needed.

No educational congress could be held in England without frequent reference to the subject of examinations. Questions of organisation and control, the influence examinations exercise, or might be made to exercise, on teaching, were very fully discussed. Prof. Wertheimer, speaking as a teacher, said: "There are not a few of us who would be prepared to make the establishment of a new examination a misdemeanour, unless the examination took the place of one or more already in existence." A few good suggestions were made in the course of the discussion for the better coordination of examining bodies, but progress in this direction can scarcely be looked for until the passing of a satisfactory bill for organising secondary education.

Mr. Quintin Hogg read an interesting paper on the new polytechnics of London, and Dr. Garnett referred in detail to the efforts made by the London County Council to place the instruction given in those schools on sound educational lines. The appointment of an educational principal to each school, the insistence on practical teaching in the laboratory or workshop, the encouragement of special advanced studies suitable to each locality, and the establishment of an efficient system of inspection, are evidence of the thought and care bestowed upon the direction of these institutions. They are still, however, in an experimental stage of existence; but in the provision they afford for secondary technical instruction, particularly of that kind adapted to evening students, they serve to indicate the great progress that has been made during the last five years.

Among the descriptive papers contributed by foreign delegates, that of Herr von Deifenbach, on the system of instruction in Würtemburg, would claim first consideration, if space permitted us to enter upon this group of subjects. None of these communications, however, add much to the information already furnished in the reports of various Commissions, and in the articles on foreign schools that have appeared from time to time in these pages, and in those of other journals.

The question of commercial education was fully discussed by several speakers, including M. Siegfried, Mr. Hewins, Mr. Sidney Webb, and Mr. Organ. The cry for commercial education, when carefully defined, seldom means more than a demand for the systematic teaching of modern subjects in our secondary schools. A course of French and German intelligently taught, lessons in scientific method illustrated by laboratory work in chemistry and physics, instruction in practical mathematics with graphic exercises, and lectures on history with explanations of the growth and routes of trade would satisfy most of the requirements of those who attach value to commercial education; and schools giving such a training will probably be found in every large town, when our secondary education is fairly organised. In connection with this subject, attention may be called to a report on commercial education in Europe recently issued from the Bureau at Washington. Dr. James, the writer of the report, tells us: "There is no institution in Great Britain, which fairly deserves the name of a commercial high school. . . . England is now beginning to wake up to the necessity of this sort of education. Boards of trade, teachers' conventions, educational societies, have all begun to agitate for its introduction." And, later on, he says: "Instead of taking hold of the subject at the right end, and organising a great institution in London, which might serve as a model for such schools elsewhere, the English began their work in this field, as in many similar instances, by establishing examinations." We feel the force of this criticism; but it is a question, to be carefully considered, whether high schools of commerce, similar to our science colleges, are really needed in this country, for the training of youths between the ages of eighteen and twenty-one in the details of office work. In their papers dealing with this question, Mr. Webb and Mr. Hewins have contributed to the better apprehension of the difficulties of the subject. As pointed out by one of these writers, the highest commercial instruction must be specialised to prove useful and attractive, and it should appeal to those engaged in the particular branch of commerce to which it refers.

We cannot close this short notice of the subjects con-

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sidered at the Congress without reference to the papers on domestic economy. It must be admitted that the teaching of such subjects as cookery and laundry work has been made of late years distinctly more educative, and at the same time more practically useful. Much of this improvement is undoubtedly due to the educational experiments carried out by Mr. Hugh Gordon and by Mr. Heller, under the direction of the London School Board. The results of their work may be seen in the training schools attached to some of the polytechnics, and in the classes held in other institutions. Miss Walter's paper on "Domestic science as an element in girls' education" shows the great advance that has recently been made in the treatment of this important subject, and marks the distinction, not always clearly indicated, between the teaching of domestic science and of domestic arts. For persons qualified to give instruction in the science there is an increasing demand; and in her paper, Miss Walter gives an outline of the course of training such persons should undergo, and her suggestions do not err on the side of incompleteness.

It is doubtful whether the bulky volume, the contents of which we have endeavoured to summarise, will be read by many, even of those persons who are actually engaged in the work of technical education. Such congresses, however, serve a useful purpose in bringing people together for the interchange of opinion, and in inducing a few persons to think seriously on some of the difficulties which, owing to its wide meaning and the variety of its methods, the problems of technical education undoubtedly involve.

MICROSCOPIC STUDY OF ALLOYS.

THE study of metals with the microscope proceeds apace, and is now becoming as generally pursued among metallurgists as the determination of melting points has been during the last five years. Since the appearance of Prof. Roberts-Austen's article on "Micrographic Analysis" (NATURE, vol. lii. p. 367, 1895) of iron and steel, a large amount of work has been done; but most observers still devote themselves more or less exclusively to the study of this metal, attacking unsolved problems which seem to have great industrial importance. This tendency is unfortunate from some points of view, for the complex constitution met with in that protean element makes it less easy to explain the observed appearances until, by work on simpler alloys, a better acquaintance with the whole subject has been obtained. M. Charpy is one of those who has resisted the temptation offered by the alloys of industry, and in a recent paper[1] has given some interesting results of his investigations on binary alloys which are well worth re-statement.

It is now fairly established that microscopic examination gives an immediate analysis of alloys, which is all the more valuable for differing in its results from chemical analysis, since these differences indicate the existence of definite compounds, and elucidate the structure in other ways. The immediate analysis is now made with the aid of a planimeter, as Sauveur recommended, by which the ratio of the areas occupied in the microscopic field by the various constituents can be measured. The metal or metals forming each of these constituents can often be indicated by their colour, hardness and, above all, the effects on them of various reagents, and thus a full account of the alloy can be given.

In the normal type of constitution of binary alloys, crystals of one of the metals, or of a definite compound of the two, are seen enveloped in a second constituent, which is generally the eutectic alloy, containing both elements in a very finely-divided state. The composition of the eutectic mixture remains constant, whilst the amount of isolated crystals varies with the percentage composition of the alloy. The limiting cases of a pure definite compound or metal, and of a pure eutectic mixture may be grouped with these alloys.

Eutectic alloys vary in appearance according as they have been cooled slowly or quickly. In the latter case, the surface is uniformly striated, but the crystals or crystallites are so small, that it is difficult to obtain satisfactory photographs of them. When the solidification is slow, however, the separation into lamellæ is strongly marked, especially when viewed under high powers, and this structure is highly characteristic of eutectic alloys, being easily traced in any of them whatever the metals in the alloy may be. It is well shown in Fig. 1, which represents an alloy containing silver 66 per cent., antimony 34 per cent., magnified 500 times; the metal has been treated with sulphuretted hydrogen, which has blackened the silver and left the antimony unchanged.

FIG. 1.—Alloy of silver, 66 per cent.; antimony, 34 per cent.

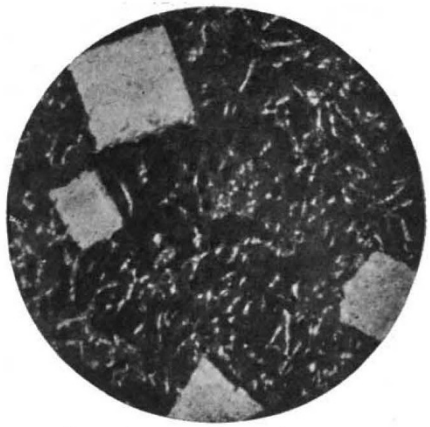

FIG. 2.—Alloy of tin, 90 per cent.; antimony, 10 per cent.

In the same figure some straight edges can be seen, in which the ramifications end, and which sketch out shapes resembling those of crystals of antimony. The presence of these crystallites or incipient crystals in eutectics constitutes one of the resemblances between them and the micro-felsitic basis observed in many igneous rocks, and it seems likely enough that if light transmitted through these alloys could be examined, it would show that they are on the borderland between crystalline and amorphous matter.

[1] "Étude Microscopique des Alliages Métalliques. *Bull. de la Soc. d'Encouragement*, vol. ii. (1897), p. 384.

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