they should be turned upside down and read from right to left," instead of from left to right. Are we to believe, on the simple dictum of Dr. Galabin that *inverted tracings*, as above explained, are developed; that every elevation in the apex cardiograph trace is the result of a movement which is represented by a fairly proportionate fall in a trace a little distance from that spot; that every apical propulsion is a lateral suction? This may possibly be the case, but it requires a considerable amount of proof before it can be accepted as true. The relative duration, or, in other words, the horizontal projections of the different undulations, is not in favour of the assumption, which seems to be based on an accidental similarity between that apex trace and the reversed one from its neighbourhood. Till Dr. Galabin introduced his view, it has been assumed that the negative trace differs from the other positive trace in the fact that in the latter some of the undulations are longer in the up than in the down stroke; whilst in the former the reverse is the case. There is need for positive disproof of this explanation before the other is even considered.

Dr. Galabin concludes that the second main systolic rise "corresponds in time to the maximum contraction of the ventricle," and that it is due to the locomotion of the heart, dependent on the consequent injection of the aorta and the propulsion of the blood. This explanation might be tenable were it not for the results obtained by the employment of the hæmodromometer of Chauveau, tracings taken with which can be found in Marey's "Circulation du Sang" (p. 273). These show that there is a regurgitant current in the carotid arteries for some appreciable period *before* the closure of the aortic valve, which can only exist in connection with a similar one in the ventricular cavity. It is the hæmodromometer trace which has led the writer of this article to lay more than usual stress on the interval between the termination of the cardiac systole and the moment of closure of the aortic valves, termed by him the diaspasis.

Dr. Galabin remarks, "Mr. Garrod attributes the elevation *d* (the first main systolic rise), solely to the locomotion of the heart caused by the lengthening of the aorta. The rise *f* (the second main rise) he considers to intervene between the end of systole and the closure of the aortic valves, and to be due to the initial relaxation of the ventricle. It appears to be impossible that the relaxation of the ventricle, apart from its repletion, could produce an elevation in the curve except in those cases in which its hardening produces a depression either at the commencement or towards the conclusion of systole." In the explanation here referred to the elevation under consideration is, however, not supposed to be the result of the relaxation of the muscular walls of the ventricles, or to have anything to do with that phenomenon, but to be caused by the reflux of blood from the aorta and pulmonary artery into the ventricles which, when it has attained a sufficient velocity, closes the semilunar valves.

Dr. Galabin, by employing the stethoscope in conjunction with the cardiograph, watching the development of the trace whilst listening to the heart-sounds, has been able to satisfactorily verify the observation that the first sound occurs during the primary up-stroke, and that the instant at which the second sound is heard corresponds to a point on the principal down-stroke, and before the succeeding small and constant rise. This is further verified by the superposition of the sphygmograph trace on the cardiograph trace taken at the same time, a method which has elsewhere been shown to lead to particularly important theoretical results.

No particular stress is laid by Dr. Galabin on the peculiarities of the cardiograph trace associated with different rapidity of pulse and nothing else. The thorough study of the subject necessitates this point being taken into consideration, as is demonstrated by the great differences there are always found in the curves derived from the same individual when the heart beats at say 45 and 125 a minute.

Most of the paper under consideration is devoted to pathological points, especially mitral stenosis or contraction. With this we cannot here deal. One particularly interesting tracing proves that in some extremely slow pulses (*e.g.* twenty-five a minute) there may be an abortive attempt towards an intermediate contraction, perceptible in the cardiograph tracing, but not seen in that from the arterial pulse.

Whilst on this subject it may be mentioned that Dr. C. Hanfield Jones has recently read a paper before the Royal Society on reversed sphygmograph tracings, or tracings in which the systole is represented by a fall instead of a rise. These he explains on the assumption that they are produced by the brass end-pad of Dr. Sanderson's modified instrument resting on the artery instead of the spring-pad. This is no doubt the true cause in many cases; these tracings are, however, in our experience sometimes produced when Marey's unmodified instrument is employed. They may sometimes result from the fact that a curved artery is, during systole, rendered part of a larger curve, and so slips from under the spring-pad at that time.

A. H. GARROD

SIR JAMES KAY-SHUTTLEWORTH ON SCIENTIFIC TRAINING

ON the occasion of presenting the prizes to the successful students at the Giggleswick Grammar School, near Settle, on July 28, Sir J. Kay-Shuttleworth made some forcible remarks on the above subject. Sir James points out with so much wisdom the relative position which science and literature ought to hold in the training of youth, that his remarks deserve the serious attention of all interested in education. Our columns constantly bear witness to the increasing prominence given to science in education, both at the higher schools and universities. Sir James, after noticing this and other features in the progress of the Giggleswick School, and referring to some of the results of the training of the school, went on to say:—

"You will perceive that among them are proofs of the influence of the practical teaching in natural science in opening a career to our pupils in the universities. In the growth of any institution on a new basis, time must be allowed for its development. Difficulties will be encountered in discipline, in domestic management, and in the attainment of the ideal to which its course of studies is expected to rise. Yet it is well to keep that ideal closely in view as the goal of all efforts; to retain a firm hold on the principles of action, and while confessing the length and the arduous character of the way, to press forward, undismayed by any partial failure, towards the summit of our hopes. I find in the examination papers a continually higher standard. They embrace a wide range of studies. But it must not be supposed that we are so presumptuous as to expect that even the *élite* of the school could attain a high degree in the whole range of these studies. No error could be more fatal than that they should be obligatory on all our pupils. Indeed, we must, in the first place, point out that in consideration of the prominence given to modern languages and to practical instruction in natural science, Greek is not among the subjects comprised in the scheme of the school, though it will be taught to all boys preparing for the universities, or for any of the public examinations. To determine how best the faculties of those not gifted with average energy and capacity can be developed requires a delicate and thoughtful discrimination. But the curriculum is open to boys in proportion to the mental and physical vigour which they bring to the task. I have said that Greek is not one of the subjects of instruction made obligatory by the scheme, and the reasons for this will become more apparent as I proceed, but among these reasons is

no want of appreciation of the ancient classical literature, or of the classical languages as means of mental culture. It may, therefore, be desirable to say that we appreciate the treasures bequeathed to us by them in philosophy, poetry, history, and art, and in the principles of jurisprudence." After speaking in high terms of the value of the classical languages as pedagogical instruments, Sir James went on :—

"But while we thus emphatically express our sense of the value of the classical languages as instruments of mental training and sources of the highest literary culture, the curriculum of this school includes pure and applied mathematics. These studies, which stretch back to the period of Greek civilisation, have grown with the development of astronomical and physical research. They are the instruments of the abstract investigation of physical laws. But we have also sought to place the school practically in relation with natural science. The question has been much discussed whether science should be thus taught through the whole school course, or whether it should be interstratified with the other studies. We shall endeavour to solve these questions by introducing in the junior forms the cultivation of the faculties of observation by the practical study of botany and physical geography, for both of which this neighbourhood affords considerable opportunities. For somewhat more advanced students we have built a good chemical laboratory, and we are about to extend this building so as to provide separate rooms and apparatus, and for the practical study of experimental physics. The thorough knowledge of any branch of experimental science involves an acquaintance with the instruments and modes of investigation, as well as skill in manipulation. These are not to be acquired from books. It is indispensable that pupils should become familiar with the phenomena of the operation of natural forces. They must learn to observe, to practise the philosophy of induction by following the footsteps of the great masters of research in preparation for independent efforts. The faculties exercised in such pursuits are not altogether the same as those employed in literary studies. They may be compared without the depreciation of either. The student of literature has opportunities to cultivate what is metaphysical—whatever relates to art, to poetry, to history, philosophy, or language; while the student of nature may more successfully develop the faculties of observation and those brought into play in the processes of inductive and deductive reasoning. The search for hidden truths trains the ripe student in habits of scrupulous exactitude. To record such observations is an exercise in accuracy of thought and language.

"The scientific habit of mind which is the result of a thorough practical training in one or more branches of science is not to be attained by any devotion to language or literature, just as the development of taste in literature, or of critical skill, or of the power of philological research and discovery cannot be gained in the laboratory. These distinctions between literature and science are in harmony with the diverse capacities of boys, and they may be employed as auxiliaries in the development of boys of limited or one-sided capacity. Some pupils who have low grammatical and linguistic power may yet exhibit facility in mathematical processes. Others in whom both these faculties are feeble, awaken to intellectual life as observers of nature. To some minds the facts and principles of science become easy only when they are in contact with the actual phenomena. Hence one part of the value of practical studies in the field and the laboratory. It may be confidently asserted that when any of these classes of mental power is feeble, the development of that part of the brain which is most easily awakened to activity will communicate vigour to the rest; the whole brain will become more healthy and active. A boy incapable of successful literary effort, but who has power as an observer, may, by that form of mental culture, by-and-by become more capable of literary application and success. Thus the literary, the mathematical, and the practical scientific studies of schools become, in the hands of a thoughtful and skilful master, preparatory or co-ordinate instruments of mental development.

"There has been of late a new era in the development of the natural sciences. This commenced with the discoveries of great mathematicians and astronomers, and extended to every department of physical research. After Kepler and Newton, mathematics in their application to experimental physics and astronomy established themselves, especially at Cambridge, as a prominent part of the studies of the European Universities. But during the present century, the rapid development of every department of natural science has created new claims for the introduction of new courses of study, for which the universities are gradually increasing their means and appliances, and towards the successful cultivation of which they are extending their honours and rewards. What happened at the revival of learning with respect to the classical literature is about to happen in the fuller recognition in the universities of every department of natural science. The Chancellor of the University of Cambridge has recently munificently founded a physical laboratory in that university. Certain of the colleges have established chemical and biological laboratories. The Geological Museum lectures and fieldwork continue to develope. These are preliminary steps towards practical instruction in every department of natural science. At Oxford, the university has built an admirable museum, with which are connected laboratories for chemical and biological studies, and for those of experimental physics and geology. Certain of the colleges have also laboratories, and readers or demonstrators of practical science. The Commission on Scientific Instruction, which has just closed its five years' labours, has made many suggestions as to the facilities to be granted to students of natural science in both universities. For example, it recommends the freer admission of those who are successful to the honours of the university, as well as to the scholarships, fellowships, and government of the colleges. The Commission had such opportunities of ascertaining to what extent these recommendations expressed the opinions of the governing minds of the universities, that there can be no doubt that no insurmountable obstacle will be encountered in the establishment of studies in natural science in a position, in relation to their honours and rewards, which will duly represent the part which science has to play in the education of the country.

"The methods and results of natural science have now so far affected all our modes of thought that they claim their place in the arena of all forms of discussion. They must, therefore, also take their place in the studies of the public and grammar schools, and of the colleges and universities which would fitly train men for the work of life. It would be a grave disadvantage to this nation if its rulers in Parliament and in the Cabinet should represent chiefly literary culture, without a familiarity with the physical sciences. Such a result could not now long exist without a neglect of opportunities of promoting scientific culture and research, which would be injurious to the education of the country and prejudicial to the development of its material resources. Perhaps it would be a much graver misfortune if there should grow up in the country two forms of thought—one derived from the exclusive contemplation of the metaphysical, and the other resulting from purely physical and materialistic studies. Moreover, to a man of education, however ripe and complete may be his classical accomplishments, it must be a great misfortune to have had no training in the natural sciences. He must have a sense of partial development, and of the deprivation of a great source of mental pleasure. These are, doubtless, among the reasons why, in the great public schools, instruction in natura

science has recently been introduced by the appointment of skilled teachers, by the building of laboratories and the establishment of museums, and by the regulations of the commission of public schools as to the time to be allotted to such studies. Among our provincial grammar schools Manchester has provided laboratories and the means of highly skilled scientific instruction. At Burnley, also, laboratories have been built, and the head master, Mr. Hough, is distinguished by his scientific knowledge and practical skill. He, doubtless, will diligently employ the means at his command. The Commission on Scientific Instruction has carefully collected the experience of the schools which have introduced practical scientific teaching. They strongly recommend that such instruction should take its place at the side of that which is literary throughout the whole school course. We had practically anticipated this suggestion at Giggleswick. I do not prominently put forward the adaptation of such studies to the wants of the great manufacturing districts of Yorkshire, Lancashire and Cumberland, which are contiguous to us, or of the Durham and Northumberland coalfield. Yet many of the sons of wealthy men in these districts, as well as of those engaged in scientific professions, will complete their education at school. In these trades and professions the practical commencement of a scientific training is often of great value. As I have already said, it forms the scientific habit of mind; it familiarises the youth with the phenomena of the operation of natural laws, and with the manipulation of instruments. It developes the faculty of observation and the power of inductive and deductive reasoning. Moreover the facts of physical science learned in the laboratory are an invaluable possession to the engineer, the chemist, the miner, the physiologist, and to every professional man who has to use these facts, principles, and processes as a part of his daily occupation. This school is intended to offer, in the first place, a sound preparation in elementary knowledge in the English language, its grammar, composition, and some acquaintance with English history and literature. Within the range of its studies are the ancient classical literature and modern languages. It would fail in its purpose if the humble elements of arithmetic were not faithfully cultivated as the basis of mathematical knowledge and scientific calculation. It is on this broad basis that we wish and hope to rear the structure of a sound and scientific culture.

"The questions which the governors of this school have attempted, through years of patient labour, to solve, are also awaiting solution in all similar schools. What are in future to be the relative positions of the literary and scientific education of our youth? How, as in this school, can the financial resources be developed so as to provide laboratories, and a larger skilled staff of teachers, in order to ensure a sound literary culture, together with scientific instruction? Inseparable from these questions is the formidable one, Whence are the skilled teachers of science, capable of giving practical instruction in laboratories to be provided, if science in this sense is to form part of the curriculum of all schools? Where the income of the school is small, that difficulty is at present insurmountable, for a separate science master cannot be afforded in such schools. Nor will it be removed until some means be devised for the training of teachers by which they will be enabled to add practical skill in scientific instruction to a sound basis of literary culture. Then a single master may fulfil the double function in a school. The commission on scientific instruction points to this, among many other reasons, for the establishment, within the universities and elsewhere, of a system of training for masters of schools above the elementary in the art and practice of teaching, and in a practical knowledge of science. The governors of this school of King Edward the Sixth of Giggleswick have not been negligent of the bearing of their labours on these wide general questions. So far as they have proceeded, they are satisfied that a sound literary culture may not only subsist with practical instruction in science, but that, under earnest and thoughtful guidance, these departments of instruction may each contribute to the intellectual activity and to the success of every form of teaching in the school."

THE INTERNATIONAL GEOGRAPHICAL CONGRESS AND EXHIBITION

THIS Congress, which has been looked forward to with considerable expectation, was opened in the Salle des Etats of the Tuileries, on Sunday last, in presence of the President of the French Republic, many of the dignitaries of State, foreign ambassadors, and other eminent persons. There was a large attendance of the general public, and addresses were given by the President of the Congress, Admiral de la Roncière le Noury, Baron von Richthofen, Sir Henry Rawlinson, and other delegates of the various nations represented at the Congress.

The regular work of the Congress commenced on Monday, and the sittings will be continued till the 11th inst., when a distribution of medals will take place. We believe a few prizes will be awarded to England, but not many, as our country has contributed but scantily to the exhibition. To-day a visit will be made to the Paris Observatory, and to-morrow one to the Historical Museum of National Antiquities (mostly pre-historic) at St. Germain.

Juries have been appointed to decide on the awards in the various sections of the Exhibition, and a notable feature of these is that not a single Frenchman has been appointed a president; this, we believe, is the result of characteristic delicacy on the part of the French authorities. Col. Montgomerie and Major Wilson are the English representatives.

The Exhibition continues to be well attended, and we hope the receipts will be sufficient to reimburse the Committee, who have become responsible for a large sum, the French Government and Geographical Society having contributed a very small amount.

In the English Section the books of photographs illustrating the people of India and China and the Chinese have proved very attractive. The photographs exhibited in the Russian annexe are very numerous, and relate to people of every tribe and condition inhabiting the empire. Austria has also been very successful in this respect, having exhibited photographs and drawings illustrating the chief incidents of the *Tegethoff* Polar Expedition.

A special room has been set apart for the several Alpine clubs, which have been created in imitation of the English Alpine Club. The publications of the parental association, and the scientific and other apparatus used in Alpine climbing by the English, French, and Italian clubs, are exhibited, and are inspected with evident interest.

The French Government exhibits the results of the missions sent out by the Ministry of Public Instruction. These have been numerous and successful. Independently of the Transit of Venus Expedition, we must mention a series of pictures showing the Bay of Santorin, in the several successive stages of creation of the new volcanic island. These illustrate happily how continents come into existence.

The Hall of National Antiquities (Pre-historic) is a compendium of the Saint Germain Museum, which will be visited by the Congress. A number of highly instructive maps, showing the distribution of relics of the Stone Age, Iron Age, &c., have been published, and are exhibited by the Historical Commission on the Gauls, which was created by Napoleon III. while writing his "Life of Cæsar," and will be continued for a lengthened period.

Amongst the real curiosities of the Exhibition, we must mention a microscopic photograph of the French map by the staff. This photograph was executed by M. Dagron,