

student should commit to memory is separately printed, and precedes the first chapter. Beginners will find it better on their first reading to omit the articles specially marked for this end, and also to make selections from the examples. It would be hard to find a better introduction to plane trigonometry book.

LETTERS TO THE EDITOR.

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Music, Rhythm, and Muscle.

IN your issue of January 18, you refer (on p. 271) to an article by Dr. Wilks in the *Medical Magazine* (which I have not seen), in which the learned author points out that music is not to be regarded in its origin as a purely spiritual faculty, but that it admits of a physiological explanation. This discussion is in itself a most interesting one. Dr. Wallace, in his well-known discussion of the relations of music to the other faculties of man, has raised this very question, or one closely allied to it. Wallaschek, as quoted by Dr. Wilks and yourself, asserts that "rhythm, or keeping time, lies at the very foundation of the musical sense." Rhythm again, he says, "can be referred to muscular contraction and relaxation," the "muscular sense being the measure of time," so that the muscular sense is intimately bound up with the idea of music. "Not in the different passions of the mind, but in muscular action, therefore, music appears to have had its origin."

My purpose in addressing you is to point out that these opinions receive a remarkable and very beautiful illustration in the history of Greek dance and rhythm, so far as these are known to us. We know but little of Greek music in the stricter sense of this word, and this perhaps for the very reason that music was not then separated from choral intonation and movement. The strophé and antistrophé of the Greek chorus, which terms we usually apply to the musical phrases sung during a movement, are primarily, of course, not these strains but the evolutions themselves, the dancing towards the one side of the orchestra or the other. Now we do know from the metrical analysis of Greek dramas and odes what these rhythms were, and we can thus probably infer the character of the music proper. By the study of Greek rhythms we shall thus find a method of tracing the genesis of music in its most elaborate modern forms from dancing and footing it in any kind of measure. Dr. Wilks well points out that muscular movement is essentially rhythmical: we may go farther and say that all movement, even the rush of falling water, is rhythmical.

The monotony of the recurrence of identical periods or colons would soon be felt, and we find accordingly that efforts are made by all early people to vary the measures. The use of two and four simple feet would soon pall, and was accordingly broken up in the Greek drama by threefold and more complex metres, as, for instance, by Pindar in his Epinikian odes. This "threefold form," says a recent writer, finds an almost exact counterpart in most of the figures of Bach's "Wohltemperiertes Klavier," and the "modern sonata has the same form on a very extended scale," the first part and its repetition corresponding with the strophé and antistrophé of the Greeks, and the second part with the epode. These curious parallels and essential similarities may be traced much farther and into elaborate detail, as is shown in part by the writer I have quoted, Mr. Abdy Williams, in the *Classical Review* for 1893 (p. 295). Mr. Williams's article, which well deserves a careful reading, is based upon the important discovery of a treatise on rhythm by Aristoxenus of Tarentum. Aristoxenus was a favourite pupil of Aristotle, and flourished about 300 B.C.; he wrote also a treatise on harmony, which less concerns us here, and he was "not only a musician, but a man of the widest culture and knowledge." Soon after the time of Aristoxenus the dependence of music on metre, which in its turn is a notation of choral movement and but a regulation of the rhythms of various muscular movement—the dependence, I say, of music on metre gave way to the ascendancy of accent. Accent, and not quantity began to

form the basis of the rhythm. Strict measure thus became less obviously the basis of music and poetical rhythm; but, says Mr. Williams, "upon the ruins of the ancient measured music arose a new and magnificent art, now known as 'Plain Song' or 'Gregorian Music,' the rhythmical construction of which is based on the natural laws of phrasing." (Compare strophé and antistrophé.)

With the disuse of plain song arose again the old metrical rhythms, but now so dissociated from choral evolutions that we have forgotten their muscular origin. The early modern composers recovered the elaborate rhythms once founded on choric phrases, but under the name of "form," and "by following the instincts of their genius, unconsciously brought about a renaissance of the natural rhythms and musical forms known to the ancient Greeks, developing them by the aid of modern resources, while adhering to certain definite principles which on examination are found to agree with those enunciated 2000 years ago by Aristoxenus of Tarentum." These, I need not repeat, were almost directly based not upon rhetorical, but upon muscular rhythms. The simpler and ruder the musical sense, the more brief and simply bipartite, or two-legged, must be the recurrent rhythms, as the popular tunes of our street organs and music halls tell us daily; the more relieved and elaborated rhythms of Bach and Beethoven need a more sustained attention and a more cultivated apprehension, while the rhythms of Wagner are so postponed in their resolutions, and so broken in their variety, that perhaps few even of good musicians can follow them with any consciousness of muscular measure, or even of "form." Therefore we call them "highly spiritualised," and forget whence they are originally derived.

Cambridge, January 28.

T. CLIFFORD ALLBUTT.

P.S.—Since writing this letter, Prof. Roy has drawn my attention to the statement that if a pencil be taken in the right hand, a sheet of paper placed below it, and the hand thrown into a rapid automatic dotting action, as the paper is drawn forward the resulting row of dots will be found to be a uniform number per second—five or seven, I forget which—and thus for all persons alike there is the basis of rhythm.

The Cloudy Condensation of Steam.

THE publication in your pages¹ of Mr. Shelford Bidwell's lecture on "The Cloudy Condensation of Steam," at the Royal Institution in May last, calls for a few remarks from me. As the points I have to refer to are principally personal, I shall be as brief as possible.

In discussing the effects of electrification on the condensation of a steam jet, Mr. Bidwell, after pointing out that though it has been shown that small particles of matter are thrown off by the electrical discharge, says that—"Yet it is remarkable that Mr. Aitken . . . gives no countenance to the nucleus theory." He then informs his hearers that he imagines I have abandoned my conclusions regarding the action of dust. It is very difficult to understand Mr. Bidwell's objection to me not countenancing the nucleus theory to explain the phenomena, as in the very next paragraph he shows I was correct in not ascribing the change in the jet when under electrification to dust particles, and gives an experiment to prove it. His experiment is different from the one on which I founded my conclusion. In some experiments made when working at this subject there did not seem to be a possibility of the dust produced by the electrical discharge getting to the jet. Take, for example, the following experiment:—The steam jet was allowed to issue from the side of a polished metal ball of about 3 c.m. diameter. This arrangement was adopted to prevent any discharge of electricity from the nozzle. At one side of the jet was placed an electrified body at a distance of about 10 c.m.; and at about the same distance on the other side of the jet was placed a flame. As no air passed either from the flame or from the electrified body to the jet, it seemed impossible the effect could be due either to particles of metal from the conductor or to particles of dust from the flame. The conclusion, therefore, was that the effect on the jet could be produced by electricity without the aid of dust. It, however, seems highly probable that the dust produced by the discharge of electricity may have some effect in such experiments as those described by Prof. Barus, in which the air from the terminals from which the discharge is taking place is carried to the jet. Prof. J. J. Thomson

¹ NATURE, December 23, 1893.