actions for 1824, 1828, and 1830. The pendulum, how ever, seems a more certain means of determining the differences in the force of gravity, than any merely theoretical formula, which cannot be expected to provide for particular local attractions. Besides, we suspect that during experiments on the velocity of sound, attention has not always been paid to the velocity and direction of the wind ; and still more rarely have these been registered and published, so as to afford data for applying the requisite correction.

In the Reports of the British Association for 1833 and 1836, we find two able and interesting articles by Professor Challis, on the mathematical theory of fluids. Among other things, he treats at considerable length on the theory of sound, giving an analysis and notices of various essays on that subject. But these the learned professor seems, after all, never to have thoroughly examined, otherwise he could not have failed to discover that, in the mathematical investigations employed in several of the papers on which he has bestowed the largest share of commendation, there are various fundamental errors and inconsistencies, which naturally enough have led their authors into results which, independently of every other consideration, are more or less erroneous, because palpably incompatible with each other and with the premises from which they are professedly de duced. Fallacies of the sort in question have been pointed out in the Edin. Phil. Journ. (for Oct. 1826, p. 335, and July 1827, p. 153), as also in various numbers of the Quarterly Journal of Science for 1829. Some of the same errors have been likewise noticed, though not so early as in the firstmentioned journal, by an eminent Italian philosopher, Mr Avogadro, in the *Memorie dell' Academia realle della Scienze di Torino* (vol. xxxiii. p. 237), and also in a sepa rate tract of his. Several notable instances of the like sort have been discussed and exposed in the article Ηυgrομεtry; but it is only one or two examples which we can notice here.

With the view of accounting for the excess of the actual velocity of sound over that given by Newton’s formula, it was very ingeniously suggested, in a general way, by the Marquis Laplace, about the beginning of the present cen tury, that, in the propagation of sound, the minute rises and falls of temperature occasioned by the alternate condensations and dilatations of the air, should tend to augment the disturbance in the equilibrium of the pressure, and consequently to accelerate the transmission of sound. He did not, however, till long after, assign the form or amount of the correction for such acceleration. The first attempt toward this seems to be that of Biot in 1802 *(Journal de Physique,* tome 1v. p. 173). But M. Poisson both claims and gets the no small credit of having very considerably anticipated Laplace in giving the precise form of the correction. This he is alleged to have done in a formula for the velocity of sound, communicated to the Institute as early as the year 1807, and shortly after published in the *Jour­nal de I'Ecole Polytechnique* (cahier xiv.), and which is meant to consist of Newton’s formula multiplied by a constant factor √1+*k*. But whilst it must be admitted that no one has written to better purpose on the theory of sound than M. Poisson has done, there seems to be a very general mistake regarding that factor. The formula is

In this he defines *g* to represent the force of gravity; *h* the height of the barometer ; D the ratio of the density of the air to that of mercury ; *θ* the temperature of the air ; *w* the augmentation of that temperature occasioned by a condensation *γ,* and so small as to be considered proportional to y ; also *a =* ∙00375 for the coefficient of the dilatation of the gases. But these evidently cannot make *k* constant, as the sequel requires it to be. After introducing the same for­

mula and explanation of symbols in another memoir insert ed in *Annales de Chimie* for May 1823, he proceeds to

show that the factor 1+ .. αu ,, , which for greater brevity he there calls simply *k,* is equal to the ratio of the spe­cific heat of air under a constant pressure to its specific heat under a constant volume ; which would identify √*k* with the above-mentioned correction given by Laplace himself, for the first time only, in the same *Annales* for November 1816,, and even then without demonstration. But it is worthy of particular notice, that the reason why the factor *k* in this case comes to be a correct expression for the ratio of the specific heats, is entirely owing to M. Poisson’s there using

*aw*

*γ* as proportional, not to *w,* as above defined, but to .

This will be readily seen on examining the *Annales* for May 1823 (p. 8 and 14), where, having put *y = —*, and *w = di,* he

deduces 7——, = *(k—1)~* ; and hence *k* = l f *~~r!~~~~V^~~*

l + oi ) 'i τ(1 + ui)⅛

= 1 + ,, °\*°.,—. Indeed, otherwise, √*k* could neither have

(1+α0z

been constant, nor coincided with the correction of Laplace.

The leading principle in these formulæ therefore is, that as long as the total heat in the air undergoes no change (which may safely be supposed to be the fact, during a much longer interval than the theory of sound requires), it is not *γ* and *w,* but the differentials of log. ( 1 f *ai)* and of log. *g* which are always held to be proportional ; and, consequently, any, changes, whether great or small, in these two logarithms themselves, must also be proportional ; so that the general expression for the ratio of the specific heats, whether the simultaneous changes of *g* to *g'*, and of *θ*to *θ'*, be great or small, will be

log. (1 4o∏1og.(1 + ot)) \_

+ Jog∙ε'lθg∙f

The above inconsistency seems to have sadly misled M. Poisson’s readers, particularly Professor Challis, as already cited ; but it is virtually included in a more serious oversight, about to be noticed, which originated in the *Méca­nique Céleste,* and has been generally more or less adopted, with implicit confidence, into almost every subsequent essay on the theories of heat and sound. In particular, it forms a leading feature in the works of Poisson, in Professor Kelland’s Theory of Heat, and in Mr Lubbock’s recent essay On the Heat of Vapours, which seems to have been hastily compiled, or, at any rate, from very incongruous materials.

When reviewing the first four volumes of the *Mécanique Céleste,* Professor Playfair expressed great doubts if there were then a dozen of persons in Britain qualified to peruse them. But whatever may now be the number of those who are content with merely reading the ordinary letterpress of that celebrated work, it is certain that almost none give themselves the trouble of thoroughly sifting the ma­thematical investigations, otherwise the serious oversights and inconsistencies which occur in some of them would be better known and appreciated, particularly the inaccuracies which pervade the greater part of the long chapter devoted to the velocity of sound. Of these, however, we shall here, for brevity’s sake, take only one instance, which is selected, not so much on its own account, but because it unfortunately lies at the foundation of many of the formulæ and results with which the seventeen quarto pages following it are chiefly occupied. In the passage referred to (tome v. p. 127), there occurs an equation of the form

⅛+^4=°∙