of atmospheric pressure, the counterpoise carried a large barometer tube, which also was immersed in mercury, and had its upper part empty like any common barometer.

A species of thermometer contrived for observing the force of solar radiation, and named an actinometer, consists of a large hollow cylinder of glass, having its upper end con­tracted and joined to a thermometer tube, terminated at the top in a hall drawn out to a point, and broken off, so as to leave a small orifice. The lower end of the cylinder is closed by a silver or silver-plated cap cemented on it, and furnished with a screw, also of silver, passing through a col­lar of waxed leather, which is pressed into forcible contact with its thread, by a tightening screw of large diameter enclosing it, and working into the silver cap by the aid of a strong key or wrench. The cylinder is filled with a deep-blue liquid, ammonio-sulphate of copper, and the ball at the top being left purposely full of air, and the point closed with melted wax, it becomes, in any given position of the screw, a thermometer of great delicacy, the tube being furnished with a graduated scale. The cylinder is enclosed in a chamber blackened on three sides, and on the fourth or face defended from currents of air by a thick glass, removeable at pleasure. The design of the screw is to vary at pleasure the capacity of the cylinder, and thus to drive, if necessary, a portion of the liquid up into the ball, which acts as a reservoir, or, if necessary, to draw back from that reservoir such a quantity as shall just fill it, leaving no bub­ble of air in the cylinder.

To use the instrument, examine, first, whether there be any air in the cylinder, which is easily seen by holding it level and tilting it, when the air, if any, will be seen to run along it. If there be any, hold it upright in the left hand, and the air will ascend to the root of the thermometer tube. Then, by alternately tightening and slackening the screw with the right hand, as the case may require, it will always be practicable to drive the air out of the cylinder into the ball, and suck down liquid, if any, from the ball to supply its place, till the air is entirely evacuated from the cylinder, and the latter, as well as the whole stem of the thermome­ter tube, is full of the liquid in an unbroken column. Then, holding it horizontally, face upwards, slowly and cautiously turn back the screw, till the liquid retreats to the zero of the scale. The observer must station himself in the sun­shine, or in some sharply terminated shadow, so that with­out inconvenience, or materially altering his situation, or the exposure of the instrument in other respects, he can hold it at pleasure alternately in full sun and total shadow, and by that means find the difference in the effects, or the force of solar radiation. If placed in the sun, he must be provided with a screen of pasteboard or tin plate, large enough to shade the whole of the lower part or chamber of the instrument, from which it should not be less than two feet distant, and should be removeable in an instant. But farther details and examples in the use of this and various other meteorological instruments will be found in the Report of the Royal Society (August 1839), on the In­structions for the Scientific Expedition to the Antarctic Region.

Ever since Dulong and Petit published their valuable researches on heat (some of which have been particularly discussed under the article Pyrometer), and in which they have made the air-thermometer the standard of tempera­ture, their example in the latter respect has been so very generally followed, as to render it of importance to ascer­tain whether the adoption of such a standard can consist with other admitted principles ; more especially since the theory of the air-thermometer, as usually laid down in first- rate books on the subject, is full of contradiction. We shall therefore now endeavour to set the matter in a pro­per light, employing for this purpose the same data, and nearly the same notation, as those with which Baron Pois­son commences his memoir in the *Annales de chimie,* tome xxiii. p. 337.

Let *g* be the density of the air, *p* the pressure, and *θ* the temperature in degrees of any common scale of an air-ther­mometer; then *a* being ∙00208 if Fahrenheit’s scale be em­ployed, and *b* another constant, we have *p — bg* (1 + *aθ*). This is commonly called the law of Mariotte, but was first discovered by Hooke when assistant to Boyle. With the centigrade scale, *a* would be ·00375; but both values of it would need to be slightly lessened if they were wished to agree with Rudberg's experiments on the expansion of air (Poggendorff’s *Annalen,* xli. and xliv.), which perhaps re­quire confirmation. Fortunately the present investigation has no dependence on the precision in the values of any constants. Let *q* be the difference between the total quan­tity of heat which a given mass of air may contain under the pressure *p* and temperature *θ,* and that which it contains under a pressure and temperature chosen arbitrarily. Then the specific heat of the air, or that which would raise its temperature one degree, being directly as *dq,* and inversely *do*

as *di,* may be expressed by *dq*/*dθ*. When such rise takes place under a constant pressure, we have from the above equation, with *p* constant, *dθ = — dg* × 1+g*θ/ag*: and when under a constant volume, or with *g* constant, *dθ = dp ×* 1+a*θ/ap*. The specific heat, when the pressure is constant, will therefore be — dq/dg × ag/1+a*θ*; and with the volume constant, dq/dg × ap/1+a*θ*. Now*,* from the experiments of

Gay Lussac and Welter, which were carried through a great range both of temperature and pressure *(Mécanique céleste,* V. 97 and 127), it appears that the former of these two specific heats always exceeds the latter in a constant ratio, which, if it be called that of *k* to *l*, we shall have

*gdq/dg + kpdq/dp =* 0..................(A).

Thus far the process does not materially differ from that pursued by Poisson and several other foreign mathemati­cians ; but on integrating this equation, their next step is to modify the integral to suit the common theory of the air-thermometer, which assumes the variations of absolute heat to be proportional to those of the volume under a con­stant pressure. In this they do not seem to have been aware that equation (A) is utterly incompatible with any such assumption, as we shall now endeavour to explain. For it is evident that the value of *dq* in the first term of the equation, is always to *dq* in the second, as — dg/g to dp/kp; whereas, if not only the differential of absolute heat in air under a constant pressure had been proportional to — dg/g the differential of the volume, but if, in like manner,

(as the common theory, when coupled with the constancy of the ratio of *k* to 1, assumes), the differential of heat un­der a constant volume had varied as *dp* the differential of the pressure, then the value of *dq* in the first term would *dp* necessarily have been to that in the second as — dg/g\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* to Ndp, where N is a constant. Now each of the former ratios is obviously the same with that of f to *p~.* which cannot

*ei hop dp* 1

coincide with the ratio of — to N⅛>, unless N = τ-; that *f i kgp*