



# On the exactness of the measurements made with mercurial thermometers

J.M. Crafts

**To cite this article:** J.M. Crafts (1883) On the exactness of the measurements made with mercurial thermometers, Philosophical Magazine Series 5, 15:91, 66-68, DOI: [10.1080/14786448308627310](https://doi.org/10.1080/14786448308627310)

**To link to this article:** <http://dx.doi.org/10.1080/14786448308627310>



Published online: 28 Apr 2009.



Submit your article to this journal [↗](#)



Article views: 2



View related articles [↗](#)

as a special instance of *subsidence*, the Achensee of a lake lying in a *faulted* line of dislocation; L. Alleghe and I. Derborence as lakes formed by Bergstürze during the last century; the prehistoric delta of the Arve as the most conspicuous instance in the Alps of the partial damming-up of a valley by diluvial detritus; the *quondam* Lake of Reutte as an instance connected with violent inversion of strata; and the ancient lakes of the Grödner and Oetz Thals as instances of the action of moraines.

The common fact of observation that lakes are more numerous in glaciated than in non-glaciated countries, the author thought, was partly explained by some of the foregoing principles, partly by the better preservation of lake-basins in glaciated countries from silting up and from becoming thus obliterated, while in some glaciated regions lakes are wanting.

## XI. Intelligence and Miscellaneous Articles.

ON THE EXACTNESS OF THE MEASUREMENTS MADE WITH  
MERCURIAL THERMOMETERS. BY J. M. CRAFTS.

A THERMOMETER with a large bulb readily indicates  $0^{\circ}002$ ; but the preciseness of the observation is restricted by slight perturbations caused by variations in the capillary resistance of the stem, by changes of pressure proceeding from barometric changes or owing to the position of the thermometer, and also by calibration-errors and the difficulty of getting a large thermometer to take the temperature of its surroundings.

Neglecting these errors, the sum of which does not exceed  $0^{\circ}02$  in suitably arranged experiments, let us examine those which are due to movements of the particles of the glass, slow movements which succeed expansion by heat, and which would involve errors if their effect could not be estimated. Some distinguished physicists have compared glass to sealing-wax: according to them, it yields to pressures, and those of the atmosphere and of the air left in the stem determine the changes of volume of the bulb of a thermometer. Others, estimating at less the part played by pressure, have cited the case of a bar of metal suspended by its extremities, which slowly becomes permanently deformed. These analogies appear to me fallacious: we have not here to do with pressures similar to the enormous force that causes the bending of a bar; we ought rather to compare the bulb of a thermometer to a leaden pipe, which nevertheless supports for years the pressure of a high column of water, whilst the least bending deforms it. Person's experiments, moreover, since confirmed by mine, showed that no important influence could be attributed to pressure.

Numerous determinations tend to prove that we have to do with motions which are but little under the influence of external forces, and that their effects can be foreseen and regulated, by which the precision of thermometric measurements can be considerably augmented.

*Depression of the Zero.*—Person supposed that thermometers heated for a long time would be rendered incapable of a depression of the zero-point; but that expectation has not been realized: the depressions produced when the thermometer is heated after a long rest cannot be put an end to. The values of these depressions have been determined by several authors; and it has been ascertained that similar experiments give numbers identical to within  $0^{\circ}01$  when the thermometers are heated to  $100^{\circ}$ ; and the errors do not exceed  $0^{\circ}04$  for higher temperatures up to  $300^{\circ}$ . The only precaution necessary is to follow one invariable method of observation: that which appears to me preferable to the rest is to let the thermometer cool in the air and then immediately observe the zero. Some observers, after an experiment at  $100^{\circ}$ , plunge the thermometer into a bath heated to  $50^{\circ}$ , and afterwards into cold baths to accelerate the cooling: equally constant results are obtained by this means; but the position of the zero is about  $0^{\circ}05$  lower than in the first case. If the thermometer be heated in a large bath holding 20 litres, and the bath and thermometer be left to cool together during twenty-four hours, the zero will be about  $0^{\circ}15$  higher than in the first case. If the zero-point be taken before the experiment, or if the experimenter wait some time before observing it, the positions will be higher, but will be more constant if he proceed methodically.

*Permanent Elevation of the Zero.*—The observations above referred to, as well as all measurements to be made with a mercurial thermometer, are singularly impeded by the permanent elevation of the zero; and the alteration of the coefficient of expansion of the glass which accompanies that phenomenon falsifies all measurements. This movement of the glass-particles varies enormously in its extent, according to the circumstances. Thus in a few hours at  $430^{\circ}$ , or in a few days at  $355^{\circ}$ , the zero can be raised  $17^{\circ}$  or  $26^{\circ}$ , whilst the writings of M. Libri and later a publication of M. Meucci's establish that, of some thermometers preserved at Florence for more than two centuries, the position of the zero has not notably changed. A fact of especial importance to us is that the permanent elevation of the fixed points, produced at a high temperature, preserves the thermometer from the effect of heat in this respect at lower temperatures. Some thermometers which were kept for eleven days heated to  $355^{\circ}$ , and were afterwards constantly, during two years and a half, submitted to experiments at all temperatures up to  $326^{\circ}$ , showed again, after being heated for half an hour to  $355^{\circ}$ , the same position of the zero, within  $0^{\circ}1$ , as after the first heating to  $355^{\circ}$ .

Thermometers intended for our ordinary laboratory experiments should be heated, before graduation and calibration, for a week or ten days in boiling mercury. That is the only appropriate way to obtain instruments that preserve the value of the degree fixed during graduation; and the errors of thermometers which have not undergone this treatment may amount to  $4^{\circ}$  for a length of  $300^{\circ}$ .

When the thermometer is intended to give lower temperatures,

it is sufficient to heat it to the highest temperature of the experiments during a very long time relatively to the duration of the subsequent experiments.

Thus a thermometer which indicates the temperature of the atmosphere, and from time to time is raised to  $100^{\circ}$  in order to fix the value of the degree, is prepared for that use by three or four days' heating to  $100^{\circ}$ . If, however, it is to serve for prolonged experiments at temperatures near  $100^{\circ}$ , the whole length of it must be heated to  $100^{\circ}$  for three or four weeks before graduation and calibration.

If a new thermometer is examined during this treatment, the value of a degree is seen to change in the proportion of about  $1:1\cdot0004$ ; and with the fixity of the zero towards the end of the heating, the value of the degree is observed to have also itself become fixed; and it remains constant if the thermometer is left at the ordinary temperature before a fresh determination of the interval from  $100^{\circ}$  to zero\*.

I agree with M. Pernet in admitting that the value of the degree does not change in ordinary observations, when there is no perceptible change in the position of the zero; but a new thermometer cannot undergo a great number of operations at  $100^{\circ}$  without one or other of its constants varying. Thanks to the kindness of M. Mascart, I have been able to submit to a long heating to  $100^{\circ}$  a thermometer which had been in use during more than ten years; and with that instrument no notable change was seen to be produced in the position of the zero. The treatment at  $100^{\circ}$  does nothing but imitate the effect of long use. The time necessary for the treatment is abridged by heating for twenty-four hours in boiling essence of turpentine, and afterwards from four days to a week to  $100^{\circ}$ ; and an analogous procedure serves for higher temperatures.

The glass must not be exposed to the corrosive action of boiling water; and metallic apparatus of easy construction permits those operations to be effected without escape and without contact of vapours of either water or mercury.—*Comptes Rendus de l'Académie des Sciences*, Nov. 13, 1882, t. xcv. pp. 910-912.

---

THEORETIC INTERPRETATION OF THE EFFECT PRODUCED BY A THIN LAYER OF OIL SPREAD OUT AT THE SURFACE OF THE SEA TO CALM THE AGITATION OF THE WAVES. BY M. VAN DER MENSBRUGGHE.

Since the remarkable experiments of Mr. Shields in Scotland, public attention has been called to the marvellous efficacy possessed by oil for calming the surges of the sea. I have the honour of

\* It is to be noted that the thing required is to compare zeros depressed to the maximum, and that the depression does not attain its limit at  $100^{\circ}$  until after an hour or an hour and a half. The time necessary to complete the depression diminishes with the elevation of the temperature.