Note on the Verification of Thermometers at the Freezing-Point of Mercury

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III. *Electromotive Force of Zinc-Tin Iodide Cell.*

A cell set up with amalgamated zinc in $\cdot 25 \text{ ZnI}_2$, $100 \text{ H}_2\text{O}$ opposed to tin in $\cdot 25 \text{ SnI}_2$, $100 \text{ H}_2\text{O}$, both solutions acidified with 1·5 per cent. of HI, was found to have an E.M.F. of from $\cdot 47$ to $\cdot 49$, averaging $\cdot 485$ volt.

There being no thermal data at my disposal no comparisons can be drawn.

XXXI. *Note on the Verification of Thermometers at the Freezing-Point of Mercury.* By G. W. WHIPPLE, B.Sc., F.R.A.S., Superintendent of the Kew Observatory*.

It is not many years since the operation of freezing mercury was considered a scientific feat, and a party of gentlemen were invited to the Kew Observatory to assist at the performance of the operation by the late Mr. R. Adams. That gentleman produced the solidified mercury by the action of ether upon carbonic acid in the solid form, and with his assistance considerable quantities of mercury were frozen, and a number of observations were made with carefully constructed thermometers, which gave the value for the melting-point of mercury which has since been accepted as the fixed point. Prof. Balfour Stewart communicated an account of these experiments to the Royal Society, in whose publications they will be found (Phil. Trans. 1863, pp. 425-435).

Since that date the determination of the low-temperature fixed point of thermometers has become a regular operation in the verification department of the Kew Observatory, and some eight or nine dozen instruments are compared in melting mercury annually, most of them being destined for use in Canada and other cold countries.

As the mode of making this comparison is not described in any readily accessible publication, we have frequently been requested to give an account of it, and have accordingly drafted this paper with a view of putting it on record.

The carbonic acid in its liquid form is purchased generally of Orchard, of High Street, Kensington, in the well-known

* Read November 14, 1885.

heavy iron bottles so familiar in lecture-rooms as recipients of compressed oxygen. A convenient quantity for the prosecution of an experiment is 200 gallons of gas, which weighs about 3 lb. The quantity of mercury operated upon is from 17 to 20 lb. By means of a common salt and ice freezing-mixture, the vessels, thermometers, mercury, and ether are all cooled down to about -10° C. beforehand.

The collecting-box being applied to the nozzle of the gas-receiver, the valve is unscrewed and gas allowed to escape through the apertures in the handles of the box for about a minute, during which time about 550 grains of solid carbonic gas are deposited in the form of snow.

The box being opened, the snow is removed with an ivory paper-knife and laid on the surface of the mercury previously placed in a wooden box well jacketed with felt. 2 oz. of ether is then poured over it, and the pasty mass forced under the surface of the mercury by means of a special wooden stirrer. The liberated gas and ether-vapour escaping through the mercury rapidly cool its temperature down, and a thin film of solid mercury forms on the top of the mass, which is immediately broken up by the stirrer. About six charges of acid snow and six fluid ounces of ether are usually necessary to convert the whole of the mercury into the finely granular mass of a pasty consistence.

It is considered inadvisable to freeze the mercury into a solid state, as then it becomes necessary to take it out of the box, and cut it up with shears into small lumps before the thermometers can be inserted into it, an operation which entails great loss of time and frozen mercury.

When the mass is in the semi-solidified condition the thermometers are plunged into it and allowed to fall to the requisite temperature—a well-verified standard being always placed in the bath at the same time and carefully watched during the progress of the comparison.

As soon as this standard is seen to begin to rise above the lowest point, the thermometers are taken out, and an additional quantity of snow and ether forced into the mercury until its temperature is again reduced, and the *feel* of the thermometer shows it has regained the proper consistency.

When the operation is properly and carefully performed, it

is found that the work of comparison may be spread over from half an hour to forty minutes, a period which permits of more than 100 mercurial thermometers being read with the necessary exactitude. If the thermometers are ordinary alcohol or Rutherford minimums with large bulbs, only from thirty to forty can be compared at a time.

The operation might be continued for an indefinite period were a sufficient supply of liquefied carbonic acid available, but at Kew we usually find the 200-gallon bottle, which, as already referred to, contains about 3 lb. weight of gas at sufficient pressure to afford snow, adequate for our purpose.

The cost of the materials is as follows :—gas 19s. 2d; ether 1s. 2d.

We do not wish to claim any credit for the process above described, but only to bring before the Members of the Society a description of our *modus operandi* as a matter which may perhaps be of a little interest to some of them.

XXXII. *Note on the Calibration of Galvanometers by a Constant Current.* By T. MATHER, Assistant in the Physical Department, City and Guilds of London Central Institution*.

THE principle of the method to be described consists in measuring the turning moment exerted on the magnetic needle of the galvanometer by a constant current, when the needle and coils are in different relative positions.

Suppose the galvanometer is placed in any position in a uniform field, and that a suitable current be passed through it, which current we will take as our *unit* current. The needle will take up some position of equilibrium, say, at an angle D to the magnetic meridian, and at angle θ to the zero of the scale (fig. 1).

When in this position, the controlling couple is $::$ to $\sin D$; and since this is balanced by the deflecting couple due to unit current, we see that this couple due to unit current, when the needle points to θ is also $::$ to $\sin D$ (fig. 1).

But in the ordinary use of the instrument the line of zeros

* Read November 28, 1885.