



LV. The reduction to normal air-temperatures of the platinum-temperatures in the low-temperature researches of Professors Dewar and Fleming

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The mechanical force cannot really depend upon μ , and the formula which leads to such a result must be erroneous.

As regards the problem of the pressure of radiation, I conclude that in this case also, and in spite of the formula, the permeability of the reflector is without effect, and that the consequences deduced by Boltzmann and Wien remain undisturbed.

Another investigation to which perhaps similar considerations will apply is that of the mechanical force between parallel slabs conveying rapidly alternating electric currents. Prof. J. J. Thomson's conclusion* is that the electromagnetic repulsion is μ times the electrostatic attraction, so that a balance will occur only when $\mu=1$. It seems more probable that the factor μ should be omitted, and that balance between the two kinds of force is realized in every case.

LV. *The Reduction to normal Air-Temperatures of the Platinum-Temperatures in the Low-Temperature Researches of Professors Dewar and Fleming.* By J. D. HAMILTON DICKSON, M.A., F.R.S.E.†

THE measurement of temperature by means of platinum depends upon the two following propositions :— (1) That for a given piece of pure annealed platinum-wire the temperature is a single-valued function of the electric resistance. This proposition is due to Prof. Callendar (1886), and has been fully verified by many subsequent observers. The second proposition is :—(2) That however different specimens of pure annealed platinum-wire may vary among themselves, nevertheless they agree in giving the same normal air-temperature of any enclosure in which they may be simultaneously placed. This proposition might, at first sight, appear as a logical deduction from the first; but a little consideration will show that the two propositions are equally fundamental, and equally necessarily due to experiment. We are indebted for it to the careful researches of Mr. E. H. Griffiths.

Theory has not yet provided the formula referred to in the first proposition; meanwhile, Prof. Callendar has devised a double formula—or, rather, a formula with a correction—which amounts to the expansion of the electric resistance of the platinum-wire in powers of the temperature, and leads to a somewhat troublesome reduction before finally

* 'Recent Researches in Electricity and Magnetism,' 1893, § 277.

† Communicated by the Author.

obtaining the normal air-temperature required. I have given reasons * to show that another empiric formula amounting to the expansion of the temperature in powers of the electric resistance of the wire, while free from some theoretical faults attached to other formulæ, is at least as good as the compound formulæ of Prof. Callendar, and evades the undesirable idea of "platinum-temperatures."

The end I had in view in getting this formula was the reduction to normal air-temperatures of the platinum-temperatures in which the results were expressed, of the many and important researches of Professors Dewar and Fleming in their varied investigations at low temperature. In furtherance of this end, Messrs. Petavel and Morris, who so ably assisted them in these investigations, told me that the piece of platinum-wire which forms the body of the platinum-thermometer employed by Professors Dewar and Fleming, and referred to as " P_1 ," is the identical piece of wire whose variations of electric resistance with temperature are given on p. 282 of *Phil. Mag.* for Sept. 1893, vol. xxxvi.† The experiments on this wire there recorded range over nearly 300° , namely, from about -200°C. to about $+100^\circ \text{C.}$ The normal air-temperatures observed are given down to the freezing-point of water, while lower temperatures are merely indicated. Thus, one low temperature which I have employed is indicated as "taken in solid carbonic acid and ether," and the other as "taken in liquid oxygen boiling at 760 millim." I have assumed that the former of these temperatures has most probably Regnault's value, $-78^\circ.2 \text{C.}$; and there seems to be a general convergence of opinion towards $-182^\circ.5 \text{C.}$ as the value of the latter.

With these data, and with the details immediately following, the annexed table has been constructed, reducing the "platinum-temperatures" expressed by means of Professors Dewar and Fleming's platinum-thermometer " P_1 " to normal air-temperatures on the centigrade scale.

* *Phil Mag.* (1897) xliv. p. 445.

† See also this paper, where it is stated that the same wire is used to measure the temperatures recorded in it, p. 275.

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Reduction to degrees centigrade of the platinum-temperatures in Profs. Dewar and Fleming's low-temperature observations as recorded by their thermometer " P_1 ."

These pt -degrees are reduced to resistances R by means of their formula

$$"R = \cdot 010975 (pt + 283\cdot 0) "$$

on p. 100, Phil. Mag. July 1895; and these resistances are then converted into centigrade degrees by formula (11) on p. 453, Phil. Mag. Dec. 1897, viz. :—

$$"(R + 20\cdot 529023)^2 = \cdot 53270015 (t + 1048\cdot 4396)."$$

pt° .	t° C.	Diff. for 1 pt° .	pt° .	t° C.	Diff. for 1 pt° .	pt° .	t° C.	Diff. for 1 pt° .
100	99 85		— 30	— 28 81		— 160	— 149 83	·902
95	94 77	1·016	— 35	— 33 61	·960	— 165	— 154 33	·900
90	89 63	1·016	— 40	— 38 39	·956	— 170	— 158 82	·898
85	84 62	1·014	— 45	— 43 16	·954	— 175	— 163 30	·896
80	79 56	1·012	— 50	— 47 92	·952	— 180	— 167 77	·894
75	74 52	1·008	— 55	— 52 68	·952	— 185	— 172 22	·890
70	69 49	1·006	— 60	— 57 42	·948	— 190	— 176 67	·890
65	64 47	1·004	— 65	— 62 15	·946	— 195	— 181 11	·888
60	59 46	1·002	— 70	— 66 83	·942	— 200	— 185 53	·884
55	54 46	1·000	— 75	— 71 57	·942	— 205	— 189 94	·882
50	49 47	·998	— 80	— 76 26	·938	— 210	— 194 34	·880
45	44 49	·996	— 85	— 80 94	·936	— 215	— 198 73	·878
40	39 52	·994	— 90	— 85 61	·934	— 220	— 203 11	·876
35	34 57	·990	— 95	— 90 27	·932	— 225	— 207 47	·872
30	29 63	·988	— 100	— 94 92	·930	— 230	— 211 82	·870
25	24 70	·986	— 105	— 99 56	·928	— 235	— 216 17	·870
20	19 78	·984	— 110	— 104 18	·924	— 240	— 220 51	·868
15	14 87	·982	— 115	— 108 80	·924	— 245	— 224 83	·864
10	9 97	·980	— 120	— 113 41	·922	— 250	— 229 13	·860
5	5 08	·978	— 125	— 118 00	·918	— 255	— 233 43	·860
0	0 20	·976	— 130	— 122 58	·916	— 260	— 237 72	·858
— 5	— 4 66	·972	— 135	— 127 15	·914	— 265	— 242 00	·856
— 10	— 9 51	·970	— 140	— 131 71	·912	— 270	— 246 26	·852
— 15	— 14 35	·968	— 145	— 136 25	·908	— 275	— 250 51	·850
— 20	— 19 18	·966	— 150	— 140 79	·908	— 280	— 254 76	·850
— 25	— 24 00	·964	— 155	— 145 32	·906	— 283	— 257 30	·847
		·962			·902			

The numbers in *italics* are outside the range of experiment.

This table is available for the following papers :—

1. The electrical resistance of metals and alloys at temperatures approaching the absolute zero. *Phil. Mag.* (1893) xxxvi. p. 271; *Electrician* (1893), xxxi. p. 529.
2. Thermo-electric powers of metals and alloys between the temperatures of the boiling-point of water and the boiling-point of liquid air. *Phil. Mag.* (1895) xl. p. 95; *Electrician* (1895), xxxv. p. 365.
3. The variation in the electric resistance of bismuth when cooled to the temperature of solid air. *Phil. Mag.* (1895) xl. p. 303; *Electrician* (1895), xxxv. p. 612.
4. Electric and magnetic research at low temperatures. *Electrician* (1896), xxxvii. pp. 301, 338.
5. On the electrical resistivity of bismuth at the temperature of liquid air. *Proc. Roy. Soc.* (1896-97) lx. p. 72.
6. On the electrical resistivity of pure mercury at the temperature of liquid air. *Proc. Roy. Soc.* (1896-97) lx. p. 76.
7. On the magnetic permeability and hysteresis of iron at low temperatures. *Proc. Roy. Soc.* (1896-97) lx. p. 81.
8. Note on the dielectric constant of ice and alcohol at very low temperatures. *Proc. Roy. Soc.* (1896-97) lxi. p. 2; *Electrician* (1897), xxxviii. p. 748.
9. On the dielectric constants of certain frozen electrolytes at and above the temperature of liquid air. *Proc. Roy. Soc.* (1896-97) lxi. p. 299.
10. On the dielectric constants of pure ice, glycerine, nitrobenzol and ethylene dibromide at and above the temperature of liquid air. *Proc. Roy. Soc.* (1896-97) lxi. p. 316.
11. On the dielectric constants of certain organic bodies at and below the temperature of liquid air. *Proc. Roy. Soc.* (1896-97) lxi. p. 358.
12. On the dielectric constants of metallic oxides dissolved or suspended in ice cooled to the temperature of liquid air. *Proc. Roy. Soc.* (1896-97) lxi. p. 368.
13. Further observations on the dielectric constants of frozen electrolytes at and above the temperature of liquid air. *Proc. Roy. Soc.* (1896-97) lxi. p. 380.
14. Electric research at low temperatures. *Electrician* (1897), xxxix. p. 645.
15. A note on some further determinations of the dielectric constants of organic bodies and electrolytes at very low temperatures. *Proc. Roy. Soc.* (1897-98) lxii. p. 250.

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