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$$\begin{aligned}
 P_0 &= -2.623 \\
 P_1 &= 552.610 \\
 P_2 &= -1354.86.
 \end{aligned}$$

The differences $W-R_0$, between the given values of p and those calculated with these coefficients have been represented in the last column of table XV. They amount to little more than $\frac{1}{2}$ atmosphere. The results given in the table have been reproduced in a diagram on Pl. II ¹⁾; the curve traced there is the calculated parabola.

It follows further from the values of the coefficients, that the parabola cuts the ordinate $p=0$ in two points, where pv_A is respectively 0.00480 and 0.40307, from which follows with the formula²⁾

$$(pv_A)T = 0.99939 \{1 + 0.0036618 (T - 273^{\circ} 09)\}$$

for the corresponding temperatures measured on the absolute scale,

$$T_1 = 1^{\circ}.3 \qquad T_2 = 110^{\circ}.2.$$

The top of the parabola lies at a pressure of 53.73 atms. the value of pv_A is here 0.20394, from which follows, in connection with the value of $\left(\frac{d(pv_A)}{dt}\right)_{p=53.73}$ determined from the isotherms, viz. 0.0053, for the absolute temperature of the isotherm which passes through the top that

$$T = 63^{\circ}.5. \text{ } ^3)$$

Physics. — “*On the measurement of very low temperatures. XIV. Reduction of the readings of the hydrogen thermometer of constant volume to the absolute scale.*” By Prof. H. KAMERLINGH ONNES and C. BRAAK. Communication N^o. 97^b from the Physical Laboratory at Leiden.

(Communicated in the meeting of Jan. 26, 1907).

§ 1. Introduction.

As it is till now difficult to obtain pure helium, and very easy to obtain pure hydrogen (c.f. Comm. N^o. 94^f, June 1906), the scale of the normal hydrogen thermometer (that with constant volume under a pressure of 1000 m.M. of mercury at 0^o) is for the

¹⁾ The temperatures have been given in absolute degrees below zero. The temperatures noted down on the plate undergo slight alterations on account of a more accurate calculation of the corrections to the absolute scale. They become $-103^{\circ}.54$, $-135^{\circ}.67$, $-182^{\circ}.75$, $-195^{\circ}.20$, $-204^{\circ}.62$, $-212^{\circ}.73$ and $-217^{\circ}.32$.

²⁾ This value of A_{A0} has been calculated from SCHALKWIJK's determinations of isotherms (cf. the conclusion of § 10).

³⁾ In this the corrections to the absolute scale have been taken into account.

present, just as when it (1896) was first mentioned as the basis of the measurement of low temperatures at Leiden in the first communication (N^o. 27) on this subject, still the most suitable temperature-scale to determine low temperatures down to -259° unequivocally with numerical values, which come nearer to the absolute scale than those on any other scale. It is therefore of great importance to know the corrections with which we pass from the normal hydrogen-scale to the absolute one.

As is known they may be calculated for a certain range of temperatures, when the equation of state for this region of temperature has been determined at about normal density. Up to now we had to be satisfied for that calculation for the hydrogen thermometer below 0° with equations of state of hydrogen obtained in a theoretical way. BERTHELOT¹⁾ derives them by means of the law of the corresponding states from experimentally determined data of other substances in the same region of reduced temperature. CALLENDAR²⁾ modifies VAN DER WAALS' equation of state so as to render it adapted to represent the results of the experiments of JOULE—KELVIN for air and nitrogen as well as those for hydrogen between 0° and 100° , and supposes that a same form of equation holds also for hydrogen outside this region. Chiefly this comes to the same thing as the application of the law of the corresponding states, albeit to a limited group of substances. Though such theoretic corrections as have been given by BERTHELOT and CALLENDAR are a welcome expedient to help us in default of other data³⁾, yet an experimental determination of these corrections remains necessary.

We have obtained them in this research by using the isotherms of hydrogen between -104° C. and -217° C. given in Comm. N^o. 97^a.

¹⁾ Sur les thermomètres à gaz, Travaux et Mémoires du Bureau International, T. XIII.

²⁾ Phil. Mag. [6] 5, 1903.

³⁾ WROBLEWSKI's determinations of isotherms at the boiling point of ethylene and oxygen are not accurate enough for this purpose. In the results found for the last temperature this is immediately apparent from the irregular situation of the points on the isotherm. The values obtained at the boiling-point of ethylene give more harmonious results. And yet a correction on the absolute scale would follow from them which has the wrong sign, viz. $-0^{\circ}.07$.

At the temperature of liquid air TRAVERS has determined the difference of the hydrogen thermometer of constant volume and constant pressure, from which we may also derive the corrections to the absolute scale for these temperatures. It is obvious that this derivation cannot be very trustworthy.

Further it is now possible (see § 1 of Comm. N^o. 97^a) to derive data on the expansion of hydrogen at low temperatures from the determinations of WITKOWSKI; they will be discussed in a following communication.

For the calculation of these corrections at a definite temperature we might start from the individual virial coefficients in the development into series of the equation of state (cf. Comm. N^o. 71, 1901), which we have derived in § 12 of Communication N^o. 97^a. The results obtained in this way show really a regular course¹), in spite of the small number of points on the isotherms.

However, we wished first to adjust the results of the separate isotherms by general formulae of temperature. Both in this case and in general it is very difficult to succeed in this by application of one of the equations of state drawn up in a finite form. Very suitable for such a purpose is the general development into series (or more strictly speaking, development into a polynomial), which has already been mentioned frequently. We chose for this the form VII. 1 (cf. the footnote to § 12 of Comm. N^o. 97^a). The adjustment takes place by calculating for every isotherm modifications in B and C , ΔB and ΔC , which we call individual ΔB and ΔC , with an approximate value of the correction to the absolute scale, by then representing the values of ΔC by a general formula of the temperature, and by computing new values for ΔB by successive approximation in such a way that the value for the correction on the absolute scale corresponds to the assumed value of T . Finally also the values of ΔB were represented by a general formula of the temperature.

If we put the new values of B and C obtained by the aid of these corrections, which *special* values we denote by VII. H₂. 1 in the polynomial of state, then this represents at the same time the determinations of isotherms of Comm. N^o. 70 at 20° very satisfactorily, and those of Comm. N^o. 78 at 0° and 20° by approximation.

By means of these general expressions the reductions on the absolute scale have been carried out.

If B and C are known there is another way to derive the absolute temperature from the observations with the hydrogen thermometer, than by applying the corrections which lead from the hydrogen scale to the absolute temperature scale. In the calculation of the temperature from the observations we may namely take at once into account, that the gas in the thermometer does not follow the law of BOYLE-CHARLES, but that pressure and volume are connected in the way, as is indicated by the development into series with the corrected values of B and C . The formula which may serve for this purpose, is given in § 5.

¹) Only the isotherm of $-135^{\circ}.71$ gives a deviating result. (See the conclusion of § 12 of the preceding communication).

§ 2. *Reduction of the readings of the hydrogen thermometer of constant volume to the absolute scale.*

If v is the volume of the gas in the thermometer, expressed in the theoretical normal volume, p the pressure in atmospheres, T the absolute temperature, the equation of state for the thermometer gas may be written in the form:

$$pv = AT \left(1 + \frac{B'T}{v} + \frac{C'T}{v^2} \right) (2)$$

Further we put:

t the temperature on the scale of the hydrogen thermometer of constant volume

and

$$T - T_{0^\circ \text{C.}} = \theta.$$

t is determined by

$$t = \frac{(pv)T - (pv)_0}{(pv)_0 \alpha_p},$$

where α_p represents the mean pressure-coefficient between 0° and 100° for the thermometer with the specific volume v . This is given

$$\text{by } \frac{(pv)_{100} - (pv)_0}{100 (pv)_0}.$$

If we represent the correction on the absolute scale by:

$$\Delta t = \theta - t,$$

we may write for this:

$$\Delta t = \frac{(T - T_0) \left(\frac{T_{100} B'_{100} - T_0 B'_0}{100 v} + \frac{T_{100} C'_{100} - T_0 C'_0}{100 v^2} \right) - \left(\frac{T B'_T - T_0 B'_0}{v} + \frac{T C'_T - T_0 C'_0}{v^2} \right)}{1 + \frac{T_{100} B'_{100} - T_0 B'_0}{100 v} + \frac{T_{100} C'_{100} - T_0 C'_0}{100 v^2}} \quad (3)$$

In agreement with what may be derived from the mean equation of state VII. 1, it appears from our determinations, that the influence of C'_T is very slight, and down to -217° does not amount to more than $0^\circ.0003$, so that it has not to be taken into account. Therefore in what follows will be put $C'_T = 0$, as is also done by BERTHELOT but without proof.

For the absolute zero point the value $273^\circ.09$ ¹⁾ is assumed, from

¹⁾ From AMAGAT's experiments with the development into series of Comm N^o. 71 (cf. the note to § 12 of Comm. N^o. 97^a) 1.26×10^{-5} was found for the difference between the pressure-coefficients of nitrogen at 1000 mm. pressure and 0 mm. pressure, from which follows with CHAPPELUS' pressure-coefficient for 1000 mM., i. e. 0.0036744 the value 0.0036618 for the limiting value at 0 mM. pressure, corresponding to the absolute zero point $-273^\circ.09$. In the same way hydrogen gives for the difference of the pressure-coefficients at 1090 mM. and 0 mM. 2.1×10^{-5} , which with the pressure-coefficient 0.0036629 given in Comm. N^o. 60 (see XV) gives

which follows $A_T = 0.0036618 T$, $T_{0^\circ\text{C.}} = 273^\circ.09$ and $T_{100^\circ\text{C.}} = 373^\circ.09$.

For the reduction of the data given in Comm. N^o. 97^a to the theoretical normal volume the value $\frac{vA}{v} = 0.99939$ was taken, borrowed from the determinations of isotherms of Comm. N^o. 70 (SCHALKWIJK).

The values of B'_0 and B'_{100} have been derived from the same determinations of isotherms¹⁾ by the aid of the pressure-coefficient 0.0036629 (see XV at the end of this Communication), neglecting the correction to the absolute scale for 20°. These values are:²⁾

$$B'_0 = 0.000607 \quad B'_{100} = 0.000664$$

The values of B'_T were found from the VII. H₂. 1 already more fully discussed in § 1, which gives in a reduced form³⁾

$$10^8 \mathfrak{B} = + 173.247 t - 462.956 - 706.416 \frac{1}{t} + 384.2458 \frac{1}{t^3} - 4.2530 \frac{1}{t^5}$$

whereas VII. 1 gives:

$$10^8 \mathfrak{B} = 157.9500 t - 305.7713 - 231.8247 \frac{1}{t} - 97.5686 \frac{1}{t^3} - 4.2530 \frac{1}{t^5}$$

From this the values of B'_T have been calculated for the standard temperatures of the isotherms.

The subjoined table contains in the first column these standard temperatures t_s measured on the scale of *our* hydrogen thermometer,⁴⁾

the limiting value 0.0036608. The same value as was found above from nitrogen, was derived by BERTHELOT (loc. cit.) from CHAPPUIS' results for nitrogen and those for hydrogen obtained with a thermometer-reservoir of hard glass. In the same paper he derives the value 273° 08 for the absolute zero-point for the case that also the less concordant results found by CHAPPUIS for hydrogen with a platinum-thermometer are taken into account. Afterwards (see Zeitschrift für Elektrochemie N^o. 34, 1904) the first mentioned value 273° 09 is again found by taking the mean of the above values for nitrogen and hydrogen, and those which may be derived by means of the experiments of KELVIN and JOULE.

1) Compare the conclusion of § 10 of Comm. N^o. 97^a.

2) The values found by CHAPPUIS are resp. 0.000579 and 0.000606.

Those of WIRKOWSKI are 0.000616 and 0.000688.

Those derived in Comm. N^o. 71 from the observations of AMAGAT are 0.000669 and 0.000774.

3) According to DEWAR, $p_K = 15$ atms. and $T_K = 29^\circ$ are used for the calculation, which also served for the derivation of VII. 1.

Further have been put $A_{A0} = 0.99939$ and $A_A = A_{A0} (1 + 0.0036618 t)$.

4) The slight differences with the value of table XII of Comm N^o. 97^a are due to a correction (see XV) in consequence of the application of the improved pressure-coefficient 0.0036629 and the influence of the dead space on the determinations of the temperature, which will be more fully discussed in the last part of this communication.

in the second column the same temperatures measured on the absolute scale. The two following columns contain the corresponding values of the special B'_T and of the corrections to the absolute scale Δt_s calculated according to formula (2) for a hydrogen-thermometer of constant volume with 1090 mm. zero-point-pressure. The last column gives the corrections for the *normal* hydrogen-thermometer.

The values for $-103^{\circ}.56$ and $-135^{\circ}.70$ are less certain than the others (compare § 10 and § 11 of the preceding communication).

TABLE XVI. H_2 . Corrections to the absolute scale.				
t_s	θ	$B'_T \cdot 10^3$	Δt_s	Δt
$-103^{\circ}.56$	$-103^{\circ}.54$	$+0.3892$	$0^{\circ}.0214$	$0^{\circ}.0196$
$-135^{\circ}.70$	$-135^{\circ}.67$	$+0.2368$	$0^{\circ}.0316$	$0^{\circ}.0290$
$-182^{\circ}.80$	$-182^{\circ}.75$	-0.2327	$0^{\circ}.0530$	$0^{\circ}.0486$
$-195^{\circ}.26$	$-195^{\circ}.20$	-0.4734	$0^{\circ}.0611$	$0^{\circ}.0561$
$-204^{\circ}.69$	$-204^{\circ}.62$	-0.7244	$0^{\circ}.0683$	$0^{\circ}.0627$
$-212^{\circ}.811$	$-212^{\circ}.73$	-1.0112	$0^{\circ}.0752$	$0^{\circ}.0690$
$-217^{\circ}.40$	$-217^{\circ}.32$	-1.2167	$0^{\circ}.0796$	$0^{\circ}.0730$

With very close approximation the results of the last column may be represented by the formula:

$$\Delta t = a \frac{t}{100} + b \left(\frac{t}{100} \right)^2 + c \left(\frac{t}{100} \right)^3 + d \left(\frac{t}{100} \right)^4 \dots (4)$$

where:

$$a = -0.0143307$$

$$b = +0.0066906$$

$$c = +0.0049175$$

$$d = +0.0027197$$

The greatest deviation is three units of the last decimal.

The formula gives the value $\Delta t = 0$, both for $t = +100^{\circ}$ and for $t = 0^{\circ}$, while $\Delta t = +0^{\circ}.14$ would follow from it for $t = -273^{\circ}$.

§ 3. Accuracy of the corrections.

The influences which may cause errors in the corrections, are of two kinds.

1. Errors in the values of B'_T .

2. Errors in the data which have been used in the further derivation.

¹⁾ The difference with Comm. N^o. 97^a remaining after the correction of the preceding note is the consequence of an improvement applied in the calculation.

The latter may be reduced to the error in B'_0 and the difference of the pressure-coefficients used for the density $= 0$ and that at 0° and 1090 mM. If for the mean error in B'_0 we compare the values of B'_0 which may be derived from the data of Comm. Nos. 70 and 78 and from those of CHAPPUIS, a mean error of ± 0.000034 (about agreeing with the error per cent derived for the pv in § 11 of Comm. N^o. 97^a) follows from their deviations inter se, which corresponds with a mean error of $\pm 0^\circ.008$ at -100° and of $\pm 0^\circ.003$ at -200° for Δt .

We may further assume that the mean error in the pressure-coefficients 0.0036618 and 0.0036629 amounts to one unit of the last decimal for the first and to two units for the second, which corresponds with a mean error in Δt of $\pm 0^\circ.003$ and $\pm 0^\circ.006$ at -100° and of $\pm 0^\circ.005$ and $\pm 0^\circ.011$ at -200° .

If we further put the mean error in B'_T equal to that of B'_0 , a mean error in Δt corresponds to this of $\pm 0^\circ.006$ at -100° and of $\pm 0^\circ.002$ at -200° .

The total mean error in consequence of all these mean errors together will amount to $\pm 0^\circ.012$ for -100° and $\pm 0^\circ.013$ for -200° .

§ 4. *Comparison of the results with those which have been theoretically derived.*

Table XVII contains the corrections concerning the normal hydrogen

t	Δt		t	Δt		
	experimen- tal values	according to VII. 1		accord ng to Callendar	accord ng to Berthelot	from experi- mental values
$-103^\circ.56$	$0^\circ.0196$	$0^\circ.0017$	-10°	$0^\circ.00021$		$0^\circ.0015$
$-135^\circ.71$	$0^\circ.0200$	$0^\circ.0032$	-20°	$0^\circ.00048$		$0^\circ.0031$
$-182^\circ.80$	$0^\circ.0486$	$0^\circ.0082$	-50°	$0^\circ.00164$		$0^\circ.0082$
$-195^\circ.26$	$0^\circ.0561$	$0^\circ.0108$	-100°	$0^\circ.0054$	$0^\circ.008$	$0^\circ.0187$
$-204^\circ.69$	$0^\circ.0627$	$0^\circ.0136$	-150°	$0^\circ.0132$		$0^\circ.0337$
$-212^\circ.81$	$0^\circ.0690$	$0^\circ.0168$	-200°	$0^\circ.0311$	$0^\circ.06$	$0^\circ.0593$
$-217^\circ.40$	$0^\circ.0730$	$0^\circ.0192$	-240°		$0^\circ.18$	
240°		$0^\circ.0470$	-250°	$0^\circ.1005$		
-250°		$0^\circ.0925$				

thermometer. Besides the above mentioned values of Δt , which were directly found from the observation it contains the corrections determined according to the serial formula VII. 1 and those calculated by CALLENDAR and BERTHELOT. Moreover in the last column the corrections, which may be calculated from the experimental values adjusted with VII. H₂ according to formula (4) are given for a comparison.

Besides the corrections derived from this investigation for the zero-point-pressure of 1000 m.M., also the values found by BERTHELOT and CALLENDAR are represented on the plate. The three curves have been indicated by I, II and III in the above mentioned order. Also II and III refer to a zero-point-pressure of 1000 m.M.

The values derived by CALLENDAR and BERTHELOT by means of the law of the corresponding states appear to deviate systematically from the experimental ones. With regard to the corrections according to VII. 1., in the derivation of which formula agreement in the region of the equation of state (between 0° and -217° for hydrogen) treated here, was not aimed at, we may observe that a modification is required for VII. 1 to give as good an agreement as possible also in this region. In the first place this agreement would require that for the calculation of VII. 1 those values were assumed for the critical quantities of H₂ which follow from the data of Comm. N°. 97^a. They are $p_k = 15$ atms. and $T_k = 43^\circ$. This value of T_k would considerably increase the corrections given in table XVII according to VII. 1.

§ 5. *Formula to derive the temperature directly from the observations with the gas thermometer of constant volume.*

We suppose that the correction for the difference in pressure at the mercury meniscus and the thermometer-reservoir in consequence of the weight of the thermometer-gas is applied to H_T , and that it is so small that it may be neglected for the small volumes.

The fundamental formula for the reduction is ¹⁾:

$$pv = A_T \left(1 + \frac{B_T}{v} + \frac{C_T}{v^2} \right)$$

which may also be written in the form :

$$pv = A_T \left(1 + B_T^{(p)} p + C_T^{(p)} p^2 \right) \dots \dots (5)$$

We start from this latter formula. The equation for the gas-thermometer (cf. formula (1) of § 5 of Comm. N°. 95^e) becomes now :

¹⁾ Here v is expressed in the theoretical normal volume and hence $A_T = 1 + 0.0086618 t$. We call the value for 0° C., at which $t = 0$, A_{T_0} . It is 1.

$$\begin{aligned}
\Pi_T & \left[\frac{V_0(1+k_1 t+k_2 t^2)+\beta_1+u_1}{A_T(1+B_T^{(\rho)} H_T+C_T^{(\rho)} H_T^2)} + \frac{u_2'}{A_{t_2'}(1+B_{t_2'}^{(\rho)} H_T^2)} + \right. \\
& \quad \left. + \frac{u_2''}{A_{t_2''}(1+B_{t_2''}^{(\rho)} H_T)} + \frac{u_3}{A_{t_3}(1+B_{t_3}^{(\rho)} H_T)} + \frac{u_4}{A_{t_4}(1+B_{t_4}^{(\rho)} H_T)} \right] = \\
& = H_0 \left[\frac{V_0+\beta_2+u_1+u_2'+u_2''+u_2'''}{A_{T_0}(1+B_{T_0}^{(\rho)} H_0+C_{T_0}^{(\rho)} H_0^2)} + \frac{u}{A_{15}(1+B_{15}^{(\rho)} H_0)} \right] \dots (6)
\end{aligned}$$

This formula holds also for the carbonic acid thermometer up to the number of decimals given by CHAPPUIS. In XV we shall further discuss the deviation of the formula used by CHAPPUIS.

With a sufficient degree of approximation the formula for the determination of the temperature down to 0°.001 with a hydrogen thermometer of 1100 m.M. zero point pressure and a dead space $\frac{u}{V_0} < 0.01$ may be written in the simpler form:

$$\begin{aligned}
H_T & \left[\frac{V_0(1+k_1 t+k_2 t^2)+\beta_1+u_1}{A_T(1+B_T^{(\rho)} H_T)} + \frac{u_2'}{1+0.00366 t_2'} + \right. \\
& \quad \left. + \frac{u_2''}{1+0.00366 t_2''} + \frac{u_3}{1+0.00366 t_3} + \frac{u_4}{1+0.00366 t_4} \right] = \\
& = H_0 \left[\frac{V_0+\beta_2+u_1+u_2'+u_2''+u_2'''}{A_{T_0}(1+B_{T_0}^{(\rho)} H_0)} + \frac{u}{1+0.00366 \times 15} \right] \dots (7)
\end{aligned}$$

First an approximate value may be assumed for $B_T^{(\rho)}$. With the approximate value of the temperature found in this way a better value of $B_T^{(\rho)}$ may be determined, and the correction term for the expansion of glass calculated.

Thus we find A_T , from which the value of θ follows through

$$\frac{A_T - A_{T_0}}{0.0036618} = \theta.$$

XV. *Influence of the deviation from the law of BOYLE—CHARLES on the temperature, measured with the scale of the gas thermometer of constant volume according to the observations with this apparatus.*

§ 1. When the formulae are drawn for the calculation of the temperature on the scale of the gas thermometer of constant volume the variation of pressure of the gas both in the thermometer-reservoir

and in the dead space has as yet (see e.g. CHAPPUIS) been generally entered into the calculation, as if it took place at perfectly constant density.

The error committed in this way, is so slight for the permanent gases for small values of the dead space, that it manifests itself only in the last of the decimals given by CHAPPUIS. For CHAPPUIS' carbonic acid thermometer, however, it attains an appreciable value (the influence extends here to the last decimal but one), so that it was of importance to examine in how far it is permissible to neglect it. This appears when CHAPPUIS' formula is more closely compared with formula (6) of XIV.

The density not being constant, either in the thermometer-reservoir nor in the dead space, on account of the fact that e.g. at low temperatures gas passes from the dead space to the reservoir, and p_v as well as the pressure-coefficient varies with the density, four approximations are applied in this treatment (two for reservoir and two for dead space), all giving an error in the same direction. (Adsorption is left out of account).

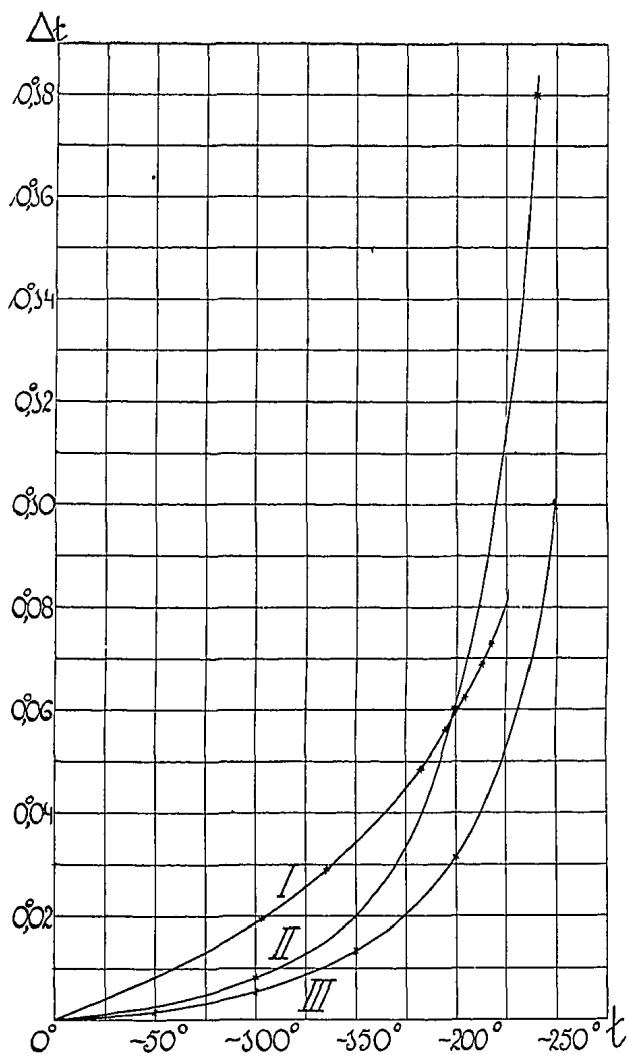
The errors caused by these approximations, are of the same order of magnitude for the reservoir and the dead space, the first applying to a large volume and a small difference of density, the second to a small volume and a large difference of density. The correction which is to be applied to the determination of temperature on account of these errors, only amounts to -0.001 at -100° for a hydrogen-thermometer with 1000 mm. zero-point-pressure and a dead space of $0.01 V_0$, to somewhat less for lower temperatures, and so it may be neglected below 0° .

Formula (6) differs from the preceding formula by one correction more, which is independent of the size of the dead space, and which is the result of the variation of density in the reservoir caused by the expansion of the glass. This error is of no importance for the determination of the temperature by the hydrogen-thermometer, but may exercise an appreciable influence in some cases. (cf. § 3).

The approximations mentioned have also an influence on the determination of the mean pressure-coefficient. The discussion, perfectly analogous to that for the influence on the determination of the temperature, gives $+0.00000019$ as correction for our thermometer, which remains below the limit of accuracy given in Comm. N°. 60. Hence the value 0.0036627 derived in Comm. N°. 60 for hydrogen at 1090 mm. changes into the corrected value 0.0036629 .

§ 2. We may pass from the temperatures derived in the way

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mentioned in Comm. N^o. 95^c to those on the normal hydrogen-thermometer by availing ourselves of the subjoined table, in which the corrections required for this have been given. These corrections give an account of the variation in the assumed pressure-coefficient and (with regard to the number of decimals given) of the influence of the dead space.

TABLE XVIII. Corrections for the temperatures calculated according to Comm. N ^o . 95 ^c to those on the normal hydrogen scale.			
<i>t</i>	Δt	<i>t</i>	Δt
— 50°	+ 0°.003	— 200°	+ 0°.016
— 100°	+ 0°.006	— 220°	+ 0°.019
— 150°	+ 0°.010	— 250°	+ 0°.020

By means of the fifth column of table XVI the corrections to the absolute scale are found. Thus the tables XVI and XVIII enable us to reduce the temperatures calculated according to Comm. N^o. 95^e and used in Comm. N^{os} 95^a, 95^c and 95^d both to the normal hydrogen scale and to the absolute scale.

The temperatures t_s occurring in Comm. N^o. 97^a, already corrected in the first column of table XVI for the application of the corrected pressure-coefficient 0.0036629 and the influence of the dead space, are adjusted to the absolute scale by the corrections in the fourth column of table XVI.

§ 3. The values found by CHAPPUIS and TRAVERS for the pressure-coefficient of hydrogen (cf. the footnote to § 7 of Comm. N^o. 95^e) are corrected to 0.00366266 and 0.00366297 (number of decimals the same as given by them).

For the pressure-coefficient of carbonic acid found by CHAPPUIS the correction is more considerable and amounts (because the dead space is small here, the correction on account of the variation of density caused by expansion of the glass is here about of the same value as that on account of the variation of density by the dead space) to -0.25×10^{-6} , so that the value found by CHAPPUIS ¹⁾ 0.00372624 is corrected to 0.00372599.

¹⁾ Nouvelles Etudes, Travaux et Mémoires du Bureau International. T. XIII, p. 48.