

LXVIII.—*A Method for Obtaining Constant Temperatures.*

By Professor WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc.,
Lecturer and Demonstrator of Chemistry, University College,
Bristol.

THE physicist and chemist often require to raise apparatus to a known temperature higher than that of the air, and to be able to vary such temperature at will, keeping it constant, if desired, for any length of time. Various devices have been used for this purpose, among which may be mentioned divers forms of water-baths, air-baths and oil-baths heated by flames the heights of which can be so regulated by thermostats as to ensure an approximately constant temperature. But all such arrangements are defective: it is impossible to avoid convection currents, even by vigorous stirring; rapid alteration of temperature is impossible, and it is a difficult and tedious operation to obtain a definite temperature.

The temperature of the vapour of a pure substance boiling under a constant pressure is practically constant throughout, the pressure of the column of vapour itself being a negligible amount; and vapours are frequently employed as heating agents, as, for example, in Hofmann's method of determining vapour-densities. But although this device is greatly superior to those already alluded to, in so far as the temperature is a constant one so long as the atmospheric pressure does not alter during the experiment, the number of liquids which are obtainable in a pure state at a reasonable cost is small, and the temperatures which can be reached by this method are at somewhat wide intervals.

It is possible, however, to alter the boiling points of such liquids by altering the pressure to which they are exposed. Their vapours then assume temperatures corresponding to the altered pressures; and as the alteration of pressure is an easy matter, complete control over temperature is to be obtained in this manner.

Liquids to be used thus must be of moderate cost; they must be easily obtained pure; they must be stable, so as not to decompose after long ebullition; and their vapour-pressures must have been determined with the greatest accuracy.

We have had occasion to make use of this means of securing accurately known temperatures; and in the hope that it may prove of equal service to others as it has to us, we publish an account of experiments made to determine the vapour-pressures of the liquids employed.

These liquids were: Carbon bisulphide, ethyl alcohol, chlorobenzene, bromobenzene, aniline, methyl salicylate, bromonaphthalene, and mercury. Their approximate boiling points are 46° , 78° , 132° , 155° , 184° , 222° , 280° , and 358° . By their use any desired temperature between that of the atmosphere and 360° may easily be obtained. These liquids also fulfil the required conditions as regards cost, purity and stability.

It is here advisable to direct attention to another advantage attending this method. The pressure is still high at which the temperature of any one of these liquids is reduced to that of the boiling point, under normal pressure, of the one next lower on the list, and a considerable alteration of pressure may be made without altering the boiling point perceptibly. Hence an alteration of temperature of one-tenth of a degree can usually be carried out with certainty. For example, the boiling point of bromobenzene under a pressure of 750.7 mm. is 155.64° . At that temperature the pressure of aniline-vapour is 337 mm., and an alteration of 1° corresponds with an alteration of pressure of 10.5 mm. As it is possible to alter the pressure by half a millimetre with perfect ease, it is evident that the temperature could be altered 0.05° by such a change.

Careful determinations of the vapour-pressures of these substances have been made. Those of carbon bisulphide, alcohol and mercury have been determined by Regnault, and his results will be quoted in the tables which follow. The vapour-pressures of the other substances were determined by us by the method described in the *Philosophical Transactions*, 1884, p. 37. A few points on the curves representing relation of pressure and temperature were determined by other methods for the purpose of reducing the readings of a mercurial, to those of an air thermometer.

As we have endeavoured to arrive at the utmost accuracy, seeing that much of our work has depended on these results, we shall discuss separately the data obtained with each substance.

The thermometers used in the preliminary determinations were of German soda-glass. They were carefully calibrated by the method of separating a single column, and the zero point and the boiling point of water were frequently redetermined during the research. For temperatures above 140° , air was introduced in order to prevent volatilisation of mercury. As the stem was always heated to the same temperature as the bulb, no correction for the expansion of the mercury in the stem was required. These readings show the general form of the curve, and may be regarded as very nearly accurate for the temperatures registered by the thermometers used. The pressures are corrected to 0° :—

I. *Chlorobenzene.*

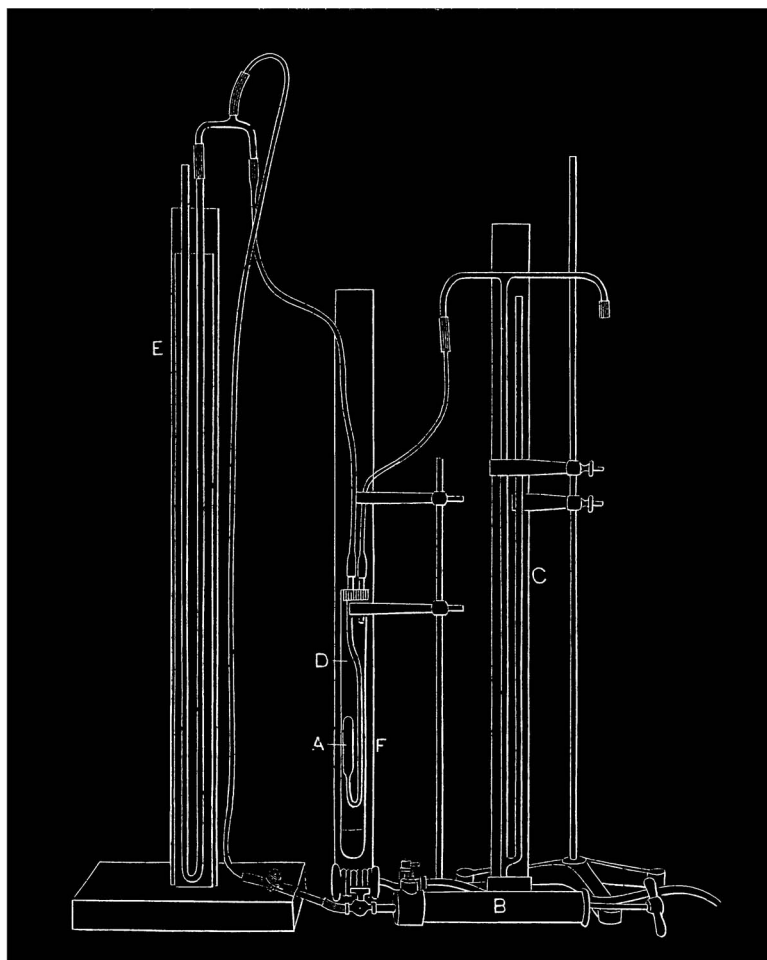
T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
26°·2	11·95	71°·6	103·1	105°·2	345·6
29·2	14·1	72·0	107·1	108·2	350·8
34·6	18·4	77·2	129·5	109·2	393·3
36·1	20·15	77·2	130·0	113·6	448·3
44·0	30·2	82·3	160·3	116·3	486·5
45·2	33·4	84·2	168·55	117·9	505·7
50·2	40·3	86·3	181·3	121·2	556·2
53·0	47·55	90·3	212·3	123·4	599·9
53·5	48·05	92·7	226·0	124·2	611·2
58·2	57·2	94·2	241·2	128·2	688·7
58·9	61·35	96·4	255·5	128·3	685·7
59·5	63·95	97·7	269·8	131·7	756·0
64·2	74·9	100·2	296·2		
65·3	80·75	101·8	307·9		

These numbers were then plotted on curve paper, and a curve was drawn showing the relationship between temperature and pressure. This curve smooths the irregularities of individual observations.

Determinations of the temperature of the vapour of chlorobenzene boiling under different pressures were then made at certain definite temperatures by means of an air thermometer. This thermometer consisted of an air reservoir, A, the capacity of which had been determined accurately to a mark on the stem, by weighing it full of mercury at a known temperature. The stem itself was calibrated, so that the volume of air contained in 1 mm. length was accurately known. It was possible, by means of the air-pump B, to alter the pressure on the air in the air thermometer, and so to alter the position of the column of mercury which confined the air in A. This alteration of pressure was shown by reading the differential manometer E, by means of a mirror scale placed behind it. It was thus possible to alter to a small extent the volume of air in A; the amount of this alteration, as well as the difference of pressure, could be read on the mirror scale placed behind A. The substance of which the vapour-pressure was required was placed in the bulb of the jacket D, and pressure could be reduced to any desired amount by means of a pump (not shown in the figure), and the exact value of the reduction of pressure read on the gauge and barometer C, which were also backed by a mirror scale. Keeping the pressure, as shown by C, constant, it was thus possible to obtain different determinations of the product of pressure of air in the air thermometer into its volume, and so, by several readings, to control the results. It may be pointed out here

that the readings of pressure were all reduced to 0° by means of the formula

$$H_0 = \frac{H_t}{1 + 0.000181t}.$$



As the temperature of the column of mercury enclosing the air in A was known from the previous determinations to within at least 1°, and as the temperatures of the gauges were taken as the same as that of the thermometers hung beside them, the reduction was accurately effected: the temperature of all parts of the mercury columns indicating pressure was known with sufficient accuracy.

The air in the air bulb necessarily became saturated with mercury-vapour, and the value of this vapour-pressure, deduced from Regnault's observations, was always subtracted from the total pressure read, before multiplying pressure by volume. Correction was also applied for the expansion of the air reservoir by heat; the coefficient of cubical expansion for the glass used was 0·0000257.

In order to show the accuracy of these observations, we think it desirable to give full details.

1. Capacity of bulb of air thermometer to zero point, 15·190 c.c.
2. Volume of 1 mm. of tube 0·011896 c.c.
3. Volume read $(15·190 + 0·011896 \times l)\{1 + (0·0000257t)\}$; (l , length of stem from zero mark to surface of mercury).
4. Pressure = $B + C + (h_1 - h_2) - \text{Hg}_t$. (B , barometric height at 0° ; b , pressure indicated by differential gauge E at 0° ; h_1 , height of mercury in open limb of air thermometer; h_2 , height of mercury in the limb connected with the bulb; Hg_t , vapour-pressure of mercury at temperature t).

The temperature t was read on a carefully calibrated thermometer by Negretti and Zambra. As it was found impossible to obtain readings when the air thermometer was jacketed with steam, owing to condensation of drops on the side of the jacket, the thermometer by Negretti and Zambra was placed in the usual form of steam jacket, and the boiling point determined. This thermometer was then immediately transferred to the apparatus, and placed in close contact with the air thermometer, the vapour of chlorobenzene being used as a jacket. Pressure was reduced until the thermometer gave the same reading as in steam at 760 mm. pressure, and the following readings of the air thermometer were taken ($t = 100^\circ$):—

B_0 .	$(h_1 - h_2)_0$	b_0 .	Hg_{100} .	P.	Zero mark.	h_2 .	l .	V.	P.V.
758·5	− 7·65	249·75	0·75	999·85	478·2	495·6	17·4	15·434	15,431
758·8	+ 12·75	222·05	„	992·85	„	506·1	27·9	15·558	15,447
„	12·0	221·85	„	991·9	„	505·5	27·3	15·551	15,425
„	31·45	196·15	„	985·65	„	515·5	37·3	15·670	15,446
759·1	54·2	163·80	„	976·35	„	527·3	49·1	15·811	15,437
„	79·35	129·10	„	966·9	„	540·0	61·8	15·963	15,435
759·35	127·1	64·05	„	949·85	„	564·5	86·3	16·255	15,440
Mean..									15,437

From the mean result, the product of pressure into volume at 0° (P_0V_0), was calculated on the assumption that the coefficient of expansion of dry air is 0·003663.

$$P_0 V_0 = \frac{P_{100} V_{100} \times 273}{273 + 100} = 11,298.$$

From the value of $P_0 V_0$ the subsequent temperatures were calculated according to the formula

$$273 + t = \frac{P_t V_t \times 273}{11,298}.$$

We think it unnecessary to give detailed results in every case, as the method has been sufficiently shown in the above examples; in order, however, that an opinion may be formed as to the correctness of the results, we give in each case the individual values of P and V ; and, as it may be deemed advisable by those using our results to employ a different coefficient of expansion for air, and to modify the numbers obtained from Regnault's determinations of the vapour-pressures of mercury at the temperatures used, we append the latter numbers.

T. (mercurial).	P. (Chloro- benzene vapour).	P.	V.	P. V.	Mean P. V.	Hgt.	T. (air).
90	mm. 208·4	mm. 982·4	15·288	15,019	—	0·5	°
"	"	974·0	15·427	15,026	15,022	"	90
100	295·7	Already given.		15,437	0·75	100	
110	400·0	1021·85	15·506	15,845	—	1·00	—
"	"	998·45	15·869	15,845	—	"	—
"	"	989·55	16·005	15,838	15,843	"	109·82
120	540·9	1049·1	15·503	16,264	—	1·50	—
"	"	1039·75	15·657	16,279	—	"	—
"	"	1028·65	15·825	16,278	—	"	—
"	"	1016·75	16·001	16,269	—	"	—
"	"	998·85	16·280	16,262	—	"	—
"	"	1047·45	15·516	16,252	16,267	"	120·06
B. p. under	750·6	1095·55	15·264	16,723	—	2·2	—
atmospheric	"	1080·65	15·499	16,748	—	"	—
pressure	"	1031·3	16·228	16,736	16,736	"	131·39
do.	753·85	1087·45	15·400	16,747	—	"	—
"	to	1080·45	15·507	16,755	—	"	—
"	754·7	1068·4	15·672	16,744	—	"	—
"	—	1042·35	16·071	16,752	—	"	—
"	—	1029·65	16·261	16,743	—	"	—
"	—	1069·0	15·671	16,753	—	"	—
"	—	1026·1	16·337	16,764	16,751	"	131·75
"	759·35	1097·0	15·276	16,758	—	"	—
"	to	1087·05	15·407	16,748	—	"	—
"	759·6	1072·95	15·606	16,744	—	"	—
		1057·9	15·848	16,765	—	"	—
		1046·8	16·004	16,753	—	"	—
		1026·05	16·330	16,756	16,754	"	131·83

These temperatures, although not quite identical throughout with

those registered by Negretti and Zambra's thermometer, were nevertheless identical with those previously obtained with the German thermometer, the difference probably depending on the nature of the glass; hence the curve representing the relations of temperature and pressure with chlorobenzene required no alteration.

The curve was then smoothed by the method of differences. The final results are as follows:—

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
25	11·4	65	79·6	105	344·15
30	14·95	70	97·9	110	402·55
35	19·45	75	119·45	115	468·5
40	25·1	80	144·75	120	542·8
45	32·1	85	174·25	125	626·15
50	40·75	90	208·35	130	718·95
55	51·35	95	247·7	135	822·0
60	64·2	100	292·75		

From this, the boiling point at 760 mm. is 132°.

II. *Bromobenzene.*

The preliminary determinations with German soda-glass thermometers are as follows:—

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
42·3	11·2	80·8	66·0	116·7	248·3
49·5	16·2	82·8	73·1	122·4	299·1
55·5	21·95	86·8	85·85	123·5	304·7
58·7	25·0	88·8	93·35	125·9	330·6
63·2	31·8	93·4	110·45	129·1	364·7
64·8	33·15	97·45	128·0	134·3	423·8
66·3	36·2	98·6	133·3	138·0	471·1
67·5	38·0	102·8	155·05	143·4	551·4
71·8	44·0	107·3	182·3	147·7	623·3
75·5	54·4	109·3	194·1	150·3	663·2
76·7	56·6	111·6	209·65	154·4	739·3

A comparison was made of the temperatures registered by the lead-glass thermometer and the air thermometer, at the boiling points of aniline and of methyl salicylate. The results of the air thermometer readings will be given under their proper headings. But it must be mentioned here that the readings of the mercury thermometer were

thus compared, for in stating results for bromobenzene, a curve was employed showing the corrections to be applied to the readings of the mercury thermometer to reduce them to readings of the air thermometer. The temperatures given are those read on the mercurial thermometer reduced by means of this curve to readings of the air thermometer.

Series I.				Series II.			
T.	P.	T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.		mm.
100° 57	143·0	140° 04	494·2	155° 22	748·0	140° 25	502·2
110·91	204·35	151·01	667·05	129·15	365·7	149·9	647·7
120·34	276·95	155·64	750·7	119·85	273·4	155·22	748·0
130·02	371·95						

The object in taking the first and last readings in series II at atmospheric pressure was to ascertain whether the zero point of the thermometer had altered during the experiment. The result proved that it had not.

These numbers, smoothed by the method of differences, give—

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
45	12·4	85	78·6	125	320·8
50	16·0	90	96·0	130	372·65
55	20·5	95	116·4	135	430·75
60	26·1	100	140·1	140	495·8
65	33·0	105	167·4	145	568·35
70	41·4	110	198·7	150	649·05
75	51·6	115	234·4	155	738·55
80	63·9	120	274·9	160	837·45

III. *Aniline.*

The preliminary determinations with soda-glass thermometers corrected for calibration, alteration of zero point, &c., are as follows :—

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
77°·4	16·2	141°·9	219·4	166°·65	474·3
85·8	24·1	144·45	237·8	168·65	497·1
93·0	33·6	147·2	260·6	169·2	507·4
99·0	43·8	147·55	263·6	171·6	542·4
105·1	56·5	150·15	286·0	171·8	544·1
110·4	70·6	152·45	307·1	173·7	575·6
118·0	94·6	152·5	307·0	174·95	592·7
123·3	114·8	155·05	333·3	176·1	612·1
124·5	118·8	157·2	355·5	177·8	638·8
128·45	137·1	157·2	356·3	178·1	646·2
129·95	145·25	159·95	387·6	180·55	690·7
132·15	156·2	161·55	406·6	181·15	701·5
134·6	169·9	162·15	411·9	182·1	719·8
135·65	177·3	164·0	436·4	184·3	762·2
137·75	191·2	165·4	452·9	184·45	763·6
139·0	199·4				

The results of the air thermometer at the boiling point under atmospheric pressure were as follows :—

T. (Hg).	B.	P.	V.	P. V.	Mean P. V.	Hg ₁₈₄ .	T. (air).
		mm.					°
184°·52	750·0	1242·2	15·228	18,916	—	12·6	—
rising to	to	1228·45	15·395	18,913	—	„	—
184·72	750·1	1220·2	15·497	18,909	—	„	—
owing to		1211·25	15·613	18,911	—	„	—
alteration		1198·85	15·778	18,915	—	„	—
of bulb		1186·55	15·941	18,915	—	„	—
during		1174·70	16·099	18,912	—	„	—
experiment.		1166·85	16·220	18,926	18,914	„	184·01

A few determinations were then taken with the English thermometer and corrected so as to register temperatures of an air thermometer.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
135°·22	175·4	150°·06	284·6	172°·06	547·5
141·79	216·0	161·12	399·1	183·87	748·5

The curve was slightly altered to coincide with these results ; and by the method of differences the following numbers were calculated :—

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
80	18·8	120	100·4	160	386·0
85	24·0	125	120·8	165	447·1
90	30·1	130	144·7	170	515·6
95	37·3	135	172·5	175	592·05
100	45·9	140	204·6	180	677·15
105	56·2	145	241·5	185	771·5
110	68·5	150	283·7	190	875·7
115	83·1	155	331·7		

IV. *Methyl Salicylate.*

The preliminary measurements are as follows :—

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
68°·7	2·25	138°·4	63·3	191°·3	335·5
72·4	2·75	142·6	73·9	195·8	386·7
89·0	6·7	146·9	85·3	200·3	434·9
94·8	9·6	152·1	103·7	204·3	484·1
97·1	10·7	158·3	126·0	207·3	521·1
98·3	11·6	165·6	158·5	210·7	571·2
100·1	12·6	171·5	189·8	213·6	614·4
113·5	22·6	176·0	219·3	216·3	656·9
114·9	23·8	182·7	266·1	218·8	698·0
125·6	38·0	183·1	269·1	220·9	728·2
125·9	38·3	187·3	298·0	222·4	761·1
134·9	54·8				

The determination of the boiling point under atmospheric pressure with the air thermometer gave the following numbers :—

T. (Hg).	B.	P.	V.	P. V.	Mean P. V.	Hg _{22·7} .	T. (air).
		mm.					
223°·8	748·75	1333·35	15·386	20,517	—	37·5	°
constant.	to	1306·50	15·696	20,507	—	—	—
	748·95	1295·05	15·829	20,498	—	—	—
		1285·2	15·974	20,530	—	—	—
		1275·7	16·211	20,528	—	—	—
		1261·0	16·525	20,514	20,515	—	—
						—	222·7

The following measurements were made with the English thermometer, its readings being reduced to those of an air thermometer :—

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
222°·4	748·0	190°·0	329·8	219°·9	706·8
169·85	183·8	199·65	426·8	222·4	748·0
179·7	246·4	210·7	566·2	—	—

To ensure coincidence with these readings, the curve required more alteration than in the previous cases. At 222° the alteration amounted to 0·35° rise, whilst at 170° the maximum decrease was 0·5°.

By the method of differences, the following series were calculated:—

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
70	2·4	125	37·1	180	249·35
75	3·4	130	45·3	185	287·8
80	4·6	135	55·05	190	330·85
85	6·05	140	66·55	195	378·9
90	7·8	145	80·0	200	432·35
95	9·95	150	95·6	205	491·7
100	12·6	155	113·6	210	557·5
105	15·85	160	134·25	215	630·15
110	19·8	165	157·85	220	710·1
115	24·55	170	184·7	225	798·05
120	30·25	175	215·1		

V. Bromonaphthalene.

The preliminary determinations gave the following numbers:—

Series I.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
113°·6	4·0	196°·8	91·8	251°·3	417·8
121·1	5·8	201·4	106·4	251·7	417·9
129·9	9·0	206·9	125·8	252·0	419·3
140·0	13·2	214·2	155·5	254·4	443·0
149·5	19·3	219·3	177·9	254·6	444·0
158·4	26·7	225·0	209·0	258·7	488·1
167·6	37·7	228·6	228·4	262·5	528·3
174·5	45·0	232·7	256·6	265·8	569·9
175·2	48·0	236·7	288·1	269·8	620·2
183·2	62·4	241·0	317·5	273·1	663·0
186·5	71·3	245·8	358·7	276·7	718·2
187·3	69·2	247·7	380·2	279·8	761·2
193·2	85·5	248·9	390·2		

Boiling point at 761.2 mm., with stem entirely in vapour, 279.9°.

A second series of experiments was carried out with three thermometers, all of German manufacture, which were, as usual, calibrated, and their fixed points determined.

Series II.

P.	T ₁ .	T ₂ .	T ₃ .	Mean.
mm.				
115.7	202.8	203.7	202.85	203.1
136.6	208.6	209.95	209.4	209.3
159.4	214.2	214.9	214.2	214.4
176.6	217.75	218.35	218.0	218.0
195.9	221.75	222.2	221.85	221.9
217.8	225.7	226.0	225.65	225.8
238.3	229.1	229.55	229.0	229.25
264.3	—	233.55	233.1	233.3
292.7	—	237.7	237.1	237.4
349.2	—	244.55	244.4	244.5
400.5	—	250.25	250.1	250.2
454.8	—	255.45	255.5	255.5
512.0	—	260.65	260.5	260.6
600.3	—	268.15	268.15	268.18
671.7	—	273.2	273.3	273.25
747.6	—	278.05	278.2	278.1

These observations, although fairly coincident with the ones already given, yet fall below the latter nearly 1°, from 205° to 225°; the difference diminishes up to 244°, where it is zero; and this remains constant up to 268°. Series II, again, falls slightly below series I up to the boiling point under atmospheric pressure, when the difference amounts to 0.8°.

As it was doubted whether so large a piece of apparatus as the air thermometer would give correct readings at so high a temperature as 280°, on account of unequal heating, and as the correction for the vapour-pressure of mercury was so large, a thermometer was constructed, the principle of which depended on the measurement of the vapour-pressure of mercury. It is necessary to rely on Regnault's results for temperature; and as Regnault determined the temperatures at which mercury boils by means of an air thermometer, the process really is an indirect method of comparing temperatures with those of Regnault's air thermometer. The very great care which Regnault took in these experiments justifies this course. The vapour-pressures of mercury only become sufficiently high to admit of accurate measurement at about 250°. Hence the number of determinations was limited.

The general arrangement of the apparatus was similar to that

employed in the air thermometer determinations. The bulb A was dispensed with, and the exit tube sealed at F. This U tube was then filled with mercury, and repeatedly boiled out so as to secure absence of air. On applying heat to the U tube, and reducing the pressure by means of the pump B, vapour was evolved from the mercury in the closed limb, and the pressure which it exerted was calculated by readings of the different heights of the mercury in the limbs of the U tube, and on a gauge at E, similar to that at C, by which the differential gauge was replaced. It is seen that no calibration is required; and indeed the process is a simple and, we believe, accurate means for the measurement of high temperatures.

The following results were obtained:—

Pressure of bromo-naphthalene.	Pressure of mercury vapour.	Temperature from Regnault's data.
756·2 mm.	157·15 mm.	280·6°
612·8	124·35	270·35

These results were checked several times.

We now possessed the means of correcting the English thermometer, so as to reduce it to air-readings. The correction to be applied at 280° amounted to — 2·43. The correction to be applied for intermediate temperatures was found from this determination, and from the previous determinations with the air thermometer by the graphic method.

A number of readings of the vapour-pressure of bromonaphthalene were finally made with the English thermometer. They are as follows, and the temperatures given are reduced to those of an air thermometer. As the zero point of the thermometer rose 0·5 during these experiments, this change may be assumed either to have occurred gradually, or to have taken place immediately after the liquid was heated. If the latter view is taken, the results make the vapour-pressures of alcohol concordant when methyl salicylate and when bromonaphthalene were used as jackets. We have, therefore, supposed that the change took place at once.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
280°·22	751·3	219°·36	178·2	259°·53	480·4
204·54	118·0	231·14	241·5	270·02	608·3
204·84	119·1	240·98	310·8	280·3	752·5
209·78	137·55	250·83	392·6		

The mean results, as in former cases, were obtained by the method of differences.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
110	3·6	170	40·75	230	235·95
115	4·4	175	48·05	235	267·85
120	5·45	180	56·45	240	303·35
125	6·8	185	66·1	245	342·75
130	8·5	190	77·15	250	386·35
135	10·6	195	89·75	255	434·45
140	13·15	200	104·05	260	487·35
145	16·2	205	120·2	265	545·35
150	19·8	210	138·4	270	608·75
155	24·0	215	158·85	275	677·85
160	28·85	220	181·75	280	752·95
165	34·4	225	207·35	285	834·35

The following tables give the vapour-pressures of the substances studied, including those determined by Regnault, for each degree between 0° and 360°, so that any desired temperature may be obtained. For the decimal parts of a degree, simple proportion gives a sufficiently accurate result :—

Carbon Bisulphide.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
0	127·9	17	264·65	34	501·65
1	133·85	18	275·4	35	519·65
2	140·05	19	286·55	36	538·15
3	146·45	20	298·05	37	557·15
4	153·1	21	309·9	38	576·75
5	160·0	22	322·1	39	596·85
6	167·15	23	334·7	40	617·5
7	174·6	24	347·7	41	638·7
8	182·25	25	361·1	42	660·5
9	190·2	26	374·95	43	682·9
10	198·45	27	389·2	44	705·9
11	207·0	28	403·9	45	729·5
12	215·8	29	419·0	46	753·75
13	224·95	30	434·6	47	778·6
14	234·4	31	450·65	48	804·1
15	244·15	32	467·15	49	830·25
16	254·25	33	484·15	50	857·1

Ethyl Alcohol.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
40	133·7	54	265·9	68	497·25
41	140·75	55	278·6	69	518·85
42	148·1	56	291·85	70	541·2
43	155·8	57	305·65	71	564·35
44	163·8	58	319·95	72	588·35
45	172·2	59	334·85	73	613·2
46	181·0	60	350·3	74	638·95
47	190·1	61	366·4	75	665·55
48	199·65	62	383·1	76	693·1
49	209·6	63	400·4	77	721·55
50	220·0	64	418·35	78	751·0
51	230·8	65	437·0	79	781·45
52	242·05	66	456·35	80	812·9
53	253·8	67	476·45		

Chlorobenzene.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
70	97·9	91	215·8	112	427·95
71	101·95	92	223·45	113	441·15
72	106·1	93	231·3	114	454·65
73	110·41	94	239·35	115	468·5
74	114·85	95	247·7	116	482·65
75	119·45	96	256·2	117	497·2
76	124·2	97	265·0	118	512·05
77	129·1	98	274·0	119	527·25
78	134·15	99	283·25	120	542·8
79	139·4	100	292·75	121	558·7
80	144·8	101	302·5	122	575·05
81	150·3	102	312·5	123	591·7
82	156·05	103	322·8	124	608·75
83	161·95	104	333·35	125	626·15
84	168·0	105	344·15	126	643·95
85	174·25	106	355·25	127	662·15
86	181·7	107	366·65	128	680·75
87	187·3	108	378·3	129	699·65
88	194·1	109	390·25	130	718·95
89	201·15	110	402·55	131	738·65
90	208·35	111	415·1	132	758·8

Bromobenzene.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
120	274·9	134	418·6	148	615·75
121	283·65	135	430·75	149	632·25
122	292·6	136	443·2	150	649·05
123	301·75	137	455·9	151	666·25
124	311·15	138	468·9	152	683·8
125	320·8	139	482·2	153	701·65
126	330·7	140	495·8	154	719·95
127	340·8	141	509·7	155	738·55
128	351·15	142	523·9	156	757·55
129	361·8	143	538·4	157	776·95
130	372·65	144	553·2	158	796·7
131	383·75	145	568·35	159	816·9
132	395·1	146	583·85	160	837·45
133	406·7	147	599·65		

Aniline.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
150	283·7	162	409·6	174	576·1
151	292·8	163	421·8	175	592·05
152	302·15	164	434·3	176	608·35
153	311·75	165	447·1	177	625·05
154	321·6	166	460·2	178	642·05
155	331·7	167	473·6	179	659·45
156	342·05	168	487·25	180	677·15
157	352·65	169	501·25	181	695·3
158	363·5	170	515·6	182	713·75
159	374·6	171	530·2	183	732·65
160	386·0	172	545·2	184	751·9
161	397·65	173	560·45	185	771·5

Methyl Salicylate.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
175	215·1	184	279·75	193	359·05
176	221·65	185	287·8	194	368·85
177	228·3	186	296·0	195	378·9
178	235·15	187	304·45	196	389·15
179	242·15	188	313·05	197	399·6
180	249·35	189	321·85	198	410·3
181	256·7	190	330·85	199	421·2
182	264·2	191	340·05	200	432·35
183	271·9	192	349·45	201	443·75

Methyl Salicylate—continued.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
202	455·35	210	557·5	218	677·25
203	467·25	211	571·45	219	693·6
204	479·35	212	585·7	220	710·1
205	491·7	213	600·25	221	727·05
206	504·35	214	615·05	222	744·35
207	517·25	215	630·15	223	761·9
208	530·4	216	645·55	224	779·85
209	543·8	217	661·25	225	798·1

Bromonaphthalene.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
215	158·85	238	288·7	260	487·35
216	163·25	239	295·95	261	498·55
217	167·7	240	303·35	262	509·9
218	172·3	241	310·9	263	521·5
219	176·95	242	318·65	264	533·35
220	181·75	243	326·5	265	545·35
221	186·65	244	334·55	266	557·6
222	191·65	245	342·75	267	570·05
223	196·75	246	351·1	268	582·7
224	202·0	247	359·65	269	595·6
225	207·35	248	368·4	270	608·75
226	212·8	249	377·3	271	622·1
227	218·4	250	386·35	272	635·7
228	224·15	251	395·6	273	649·5
229	230·0	252	405·05	274	663·55
230	235·95	253	414·65	275	677·85
231	242·05	254	424·45	276	692·4
232	248·3	255	434·45	277	707·15
233	254·65	256	444·65	278	722·15
234	261·2	257	455·0	279	737·45
235	267·85	258	465·6	280	752·95
236	274·65	259	476·35	281	768·7
237	281·6				

Mercury.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
270	123·0	274	135·05	278	148·15
271	125·9	275	138·2	279	151·6
272	128·85	276	141·45	280	155·15
273	131·9	277	144·75	281	158·7

Mercury—continued.

T.	P.	T.	P.	T.	P.
	mm.		mm.		mm.
282	162·35	309	293·55	335	497·7
283	166·1	310	299·7	336	507·5
284	169·9	311	306·1	337	517·55
285	173·8	312	312·55	338	527·65
286	177·75	313	319·2	339	537·95
287	181·8	314	325·85	340	458·35
288	185·95	315	332·7	341	559·2
289	190·15	316	339·65	342	569·95
290	194·45	317	346·8	343	580·95
291	198·75	318	353·95	344	592·2
292	203·2	319	361·3	345	603·6
293	207·75	320	368·75	346	615·25
294	212·4	321	376·4	347	626·95
295	217·1	322	384·1	348	638·9
296	221·95	323	391·95	349	651·1
297	226·8	324	400·0	350	663·2
298	231·8	325	408·1	351	675·85
299	236·9	326	416·45	352	688·55
300	242·15	327	424·85	353	701·55
301	247·5	328	433·45	354	714·75
302	252·85	329	442·15	355	728·05
303	258·4	330	450·9	356	741·55
304	263·95	331	460·1	357	755·35
305	269·6	332	469·2	358	769·4
306	275·45	333	478·55	359	783·5
307	281·35	334	488·05	360	797·75
308	287·4				

The authors beg, in conclusion, to request those chemists and physicists who make use of these tables kindly to inform them of any discrepancy which they may observe, or to point out any clerical error which they may notice.