XXV.—*On Vapour-Densities.*

By JAS. T. BROWN.

WHEN I first thought of publishing these Tables, which I now have the honour of bringing before this Society, I intended to place as an introduction to them merely the formulæ of the various vapour-density methods without note or comment, but I found that, owing to the impossibility of giving to the letters used the same significance in all the formulæ, I should, by so doing, only be adding to the difficulty of a subject which is, in some parts, rather complicated. I therefore propose to give as short a sketch as possible of the different methods, confining my remarks to the characteristic points in each, and giving the various formulæ in the shape best adapted for calculation by the aid of the accompanying tables which indicate the values of the principal terms employed in the formulæ, viz.,

$$\frac{0.0012932}{760(1 + 0.00367T)}, \frac{0.0012932}{760(1 + 0.00367t)} H \text{ and also } \frac{1 + 0.00367T}{1 + 0.00367t}, \text{ and their logarithms and log. } (1 + k(T - t)).$$

These processes may all be classed as modifications of one or other of two methods, viz., Gay-Lussac's or Dumas'; in the former the weight of substance employed is known, and the volume which it occupies under certain conditions is to be determined; in the latter the volume occupied by the vapour is known, and the weight is to be determined.

The apparatus generally described for the determination of a Gay-Lussac vapour-density consists of a graduated tube, which is held in an upright position in a large vessel of mercury, and is heated by being surrounded with hot water contained in a glass cylinder, open at both ends, which dips into the mercury, so that the column of water in the cylinder is balanced by the mercury in the outer vessel. By this method, which is only available up to 100°, we have the Gay-Lussac formula in its simplest form:—

Let P = weight of substance employed.

T = temperature of water in cylinder.

H = height of the barometer (corrected).

- t = atmospheric temperature.
 h = height of mercury in graduated tube
 above mercury in outer vessel.
 h'' = tension of mercury vapour.
 V = volume of vapour.
 k = co-efficient of expansion of glass.

The formula then becomes—

$$D = \frac{P}{\frac{0.0012932}{760(1 + 0.00367 T)} V (1 + k (T - t)) \left(H - \frac{h}{1 + 0.00018 T} - h'' \right)}$$

The calculation of the result by natural numbers is much simplified by using tables published in Vol. 4, N. S. of this Society's Journal;* but if we avail ourselves of logarithms the calculation is rendered still easier with the help of the accompanying tables. As the same expressions occur repeatedly in the various formulæ we will use the following abbreviations:—

$$\text{Let } \frac{0.0012932}{760(1 + 0.00367 T)} = \alpha$$

$$\text{and } (1 + k (T - t)) = \beta$$

$$\text{and } H' = \text{total corrected pressure on vapour.}$$

$$\text{Then } \log. D = \log. P - \log. \alpha - \log. V - \log. \beta - \log. H'.$$

The modification of Gay-Lussac's method proposed by Natanson† consists in heating the upper part of the graduated tube in an air-bath by means of charcoal, the temperature being indicated by a thermometer placed close to the graduated tube. As this process may be used at any temperature up to 300°, the correction for the tension of mercury vapour is essential.

Hofmann‡ uses a graduated tube of a metre in length (so that, before the introduction of the substance, there is a Torricellian vacuum above the mercury), surrounds the upper part of it with a larger tube, and heats it by means of steam or the vapour of any liquid which has a constant boiling point. He also prefers to use small stoppered bulbs for the substance instead of sealed ones.

Wichelhaus§ modification of Hofmann's method consists in connecting to the bottom of the graduated tube a small tube

* Journ. Chem. Soc., new series, 4, 72.

† Ann. Chem. Pharm. 98, 301.

‡ Berichte d. D. Chem. Gesellschaft, 1, 198.

§ Ibid., 3, 166.

bent upwards, so that the vessel of mercury may be dispensed with, and the whole tube may be inserted in the steam-bath.

For Gay-Lussac's determinations at any temperature up to 150° , a very convenient modification has been proposed by Greville Williams.* It consists in replacing the large vessel of mercury and the open glass cylinder by a cylinder closed and rounded at the lower extremity so as to resemble a large test-tube.

This is then filled to a depth of 50–60 mm. with mercury, and above that with water or oil to a convenient height. The graduated tube is filled and the bulb inserted over the mercurial trough; it is then immersed in the large tube by means of a rod, having at the end a small cup containing mercury. The large tube may be supported on wire gauze and heated by a Bunsen burner, or it may be heated, preferably, supported in a shallow oil-bath. The formula for this method is the same as that previously given, except that the column of water or oil, as the case may be, must be taken into account and its value in millimetres of mercury added to the pressure. In the case of water the calculation will be avoided by referring to a table given in Bunsen's Gasometry.† In using oil, its average specific gravity may be taken at 0.92, and its co-efficient of expansion at 0.0008, so that the pressure of a column h of oil at a temperature T° will be $\frac{h(0.92)}{13.59(1 + 0.0008T)}$, which at $100^{\circ} = 0.0627h$, and at $150^{\circ} = 0.0604h$.

In order to determine vapour-densities under increased pressure, some alterations in detail are required, although the principle is the same as are the processes already described. In Greville Williams's‡ method the graduated tube is, after it has been filled and the bulb has been inserted, screwed by means of a nipple cemented to the bottom, into an orifice in the top of a small metallic cistern into a second orifice in which a long open glass tube is fitted. Into this tube mercury is poured until the required pressure is obtained. If it is wished to reduce the pressure, the excess of mercury is allowed to escape by a tap in the side of the cistern. The whole is heated by being immersed in a water- or oil-bath.

In Regnault's§ apparatus for accomplishing the same object

* Watts' Dict. Chem., 5, 367.

† Bunsen's Gasometry, 285.

‡ Williams, Chem. Manip., 542.

§ Ann. Chim. Phys., 3rd series, 63, 45.

the two tubes are fastened to the bottom of the water-bath, and are connected underneath by a T-piece which is closed by a three-way cock of peculiar construction. The formula for this method is the same as the typical Gay-Lussac formula already given, but care must be taken to place the right sign before the quantity $\frac{h}{1 + 0.00018T}$, as it will be positive or negative, according to circumstances.

If it is desired to determine a vapour-density at a temperature near the boiling point of the substance, it is advisable to employ a method which was proposed by Regnault,* and simultaneously by Playfair and Wanklyn†. It consists in admitting into the graduated tube a certain volume of air or any permanent gas before heat is applied. By this means the vapour is less liable to condensation, and obeys the law of permanent gases more nearly than it would otherwise.

Then if P be the weight of substance employed,
and V be volume of gas at temperature t and pressure H ,
and V' be the volume of gas and vapour at temperature T and pressure H' ,

$$\text{then } D = \frac{P}{V' \frac{0.0012932}{760(1 + 0.00367T)} H' - V \frac{0.0012932}{760(1 + 0.00367t)} H}$$

$$= \frac{P}{V' a H' - V a H}$$

In all the methods hitherto described, the result depends to a great extent on the accuracy of the thermometer, by means of which the temperature during the experiment is determined; but in the method proposed by Grabowski,‡ many errors are eliminated, and the only thermometer required is one capable of indicating atmospheric variations of temperature. The process is conducted in the following manner:—By the side of the graduated tube, in which the substance is heated by means of gas in an air-bath specially constructed for the purpose, is placed another graduated tube, of the same length and same capacity, filled with mercury. As soon as the substance is all converted into vapour, air is passed up into the second tube

* Ann. Chim. Phys., 3rd series, 63, 45.

† Trans. Roy. Soc. Edin., 22, Part 3, 441.

‡ Sitzungsber. d., Akad. z. Wien., 53; Abth., 2, 84.

until it occupies as nearly as possible the same volume as the vapour. The vapour and air are therefore at the same temperature under similar conditions and at nearly the same pressure. The volume V and pressure H of the air, and the volume V' and pressure H' of the vapour are observed, and the apparatus is allowed to cool in order that the weight of the air employed in the experiment may be determined by measuring the volume v , which it occupies at the atmospheric temperature t , and at the pressure H'' , then if P be weight of substance employed,

$$D = \frac{P V H}{v \frac{0.0012932}{760 (1 + 0.00367t)} H'' V' H''} \text{ or very nearly } = \frac{P}{v \frac{0.0012932}{760 (1 + 0.00367t)} H''}$$

$$= \frac{P V H}{v a H'' V' H'} \text{ or very nearly } = \frac{P}{v a H'}$$

The modification proposed by Dr. W. M. Watts* consists in heating the substance, which has been weighed in a small bulb, in a globe, into the neck of which is ground a glass tube, reaching nearly to the bottom of the globe, to serve as an exit for the mercury expelled by the vapour. The volume occupied by the vapour is then calculated from the weight of mercury thus expelled, taking into consideration the capacity of the globe and the temperature during the experiment.

Then if W = weight of mercury which fills globe at t° ,
and W' = weight of mercury expelled by vapour,

and if the other letters have the same signification as in the previous formulæ—

$$\text{then } D = \frac{P}{\left[V (1 + k (T - t)) - \frac{W - W'}{13.59} (1 + 0.00018 (T - t)) \right] \frac{0.0012932}{760 (1 + 0.00367T)}}$$

$$\frac{(H + \frac{h}{1 + 0.00018T} - h)}$$

$$= \frac{P}{\left[V \beta - \frac{W - W'}{13.59} (1 + 0.00018 (T - t)) \right] a H'}$$

In using this method, it is important that the exit-tube should not be too small, otherwise the effect of capillarity will be to cause a perceptible increase in the pressure on the vapour.

* Laboratory, 1, 225.

Dumas' method, modified according to circumstances, may be used for the determination of the vapour-density of any substance boiling below a red heat, but the quantity of material required is much larger than in determinations by Gay-Lussac's method. In its ordinary form, which is available at any temperature up to 250° , the process is conducted as follows:—A globe of easily fusible glass, of a capacity of 100–200 cc., and provided with a neck which terminates in a fine point, is carefully weighed full of dry air. A portion of the substance is then introduced and the bulb heated, with the point projecting, in an oil-bath to 30 or 40° above the boiling-point of the substance; the point is then sealed and the bulb is allowed to cool, and, after being cleaned, is weighed. The temperature of the balance-case, and the height of the barometer are then noted. The bulb is then held neck downwards, partly immersed in mercury, and the point is broken off. If, as is generally the case, the mercury does not completely fill the globe, the volume of the residual air must be determined; the quickest method is that proposed by Greville Williams,* viz., to measure by means of a burette the quantity of mercury which is required to displace the bubble of air. The capacity of the globe is ascertained by measuring the mercury required to fill it. Deville and Troost† recommend determining the capacity of the globe and the volume of the residual air by weighing the mercury required.

Then if T = temperature to which the globe was heated,
 t = temperature at which the globe was weighed
after sealing,
 V = capacity of globe,
 v = volume of residual air at temperature t ,
 P = difference between the two weighings,
 H = height of barometer (corrected).

$$D = \frac{P + (V - v) \frac{0.0012932}{760 (1 + 0.00367t)} H}{\frac{0.0012932}{760 (1 + 0.00367T)} \left[V(1 + k(T - t)) - v \frac{1 + 0.00367T}{1 + 0.00367t} \right] H}$$

then if for $\frac{1 + 0.00367T}{1 + 0.00367t}$ we write γ

$$D = \frac{P + (V - v) \alpha H}{\alpha (V \beta - v \gamma) H}$$

* Phil. Trans., 1857, 460.

† Comptes Rendus, 56, 891.

Before proceeding with the consideration of the logarithmic formula, I wish to notice the reasons given in Gerhardt and Ganot for a part of the formula. I find in both these works the statement that the weight of the globe = weight of globe filled with air — weight of air contained in globe. Now, seeing that the globe is weighed in air, and with the point open, the air in the globe must be exactly counterbalanced by the surrounding atmosphere; the weight found will then be the weight of the globe, — the weight of the air displaced by the substance of the globe; this last quantity may be disregarded, as the variations in its value for any small changes of temperature will be inappreciable. The weight of the vapour will then be $P +$ the weight of the volume $(V - v)$ of air which it displaces.

In Gerhardt we find the following expression for a Dumas' vapour-density:—

$$D = A + B$$

$$\log. A = \log. V + \log. (1 + 0.00367T) - \log. (V - v) - \log. (1 + k(T - t)) - \log. (1 + 0.00367t)$$

$$\log. B = \log. A + \log. P - \log. \left(\frac{0.0012932}{760(1 + 0.00367t)} H \right) - \log. V$$

This logarithmic expression, when reduced to a formula, becomes—

$$D = \frac{P + V \frac{0.0012932}{760(1 + 0.00367t)} H}{(V - v) \left(1 + k(T - t) \right) \frac{0.0012932}{760(1 + 0.00367T)} H}$$

on examining which, it will be found that the residual air is ignored in the numerator, and in the denominator there is no correction made for its expansion; but if we modify the complete formula very slightly, we obtain the following expression:—

$$D = \frac{P + (V - v) \frac{0.0012932}{760(1 + 0.00367t)} H}{\left(V - v \frac{1 + 0.00367T}{1 + 0.00367t} \right) \left(1 + k(T - t) \right) \frac{0.0012932}{760(1 + 0.00367T)} H}$$

which is correct in the numerator, and in the denominator only introduces the small error of $v \frac{1 + 0.00367T}{1 + 0.00367t} k(T - t)$ which is inappreciable, unless the volume of the residual air be large and a high temperature be employed in the experiment.

In order to avail ourselves of logarithms we must use the form $D = A + B$.

$$\begin{aligned} \text{then } \log. A &= \log. P - \log. \left(V - v \frac{1 + 0.00367 T}{1 + 0.00367 t} \right) - \log. (1 + k (T - t)) \\ &\quad - \log. \left(\frac{0.0012932}{760(1 + 0.00367 T)} H \right) \\ \text{and } \log. B &= \log. \left(\frac{0.0012932}{760(1 + 0.00367 t)} H \right) + \log. (V - v) + \log. A - \log. P. \\ \text{and } \log. A &= \log. P - \log. (V - v \gamma) - \log. \beta - \log. \alpha - \log. H \\ \text{and } \log. B &= \log. (\alpha H) + \log. (V - v) + \log. A - \log. P \end{aligned}$$

Regnault's* modification consists in heating the substance in the globe under diminished pressure, and therefore at a much lower temperature than is possible by the ordinary method. The pressure (H) must be ascertained by means of a manometer connected with the apparatus. The details and formula are the same as in the original method, except that the neck of the globe is made very narrow at one point to admit of its being sealed off while still connected with the manometer.

For determinations at temperatures above that at which a mercurial thermometer can be conveniently used, *i.e.*, above 300° , it is proposed by Deville and Troost† to heat the globes in the vapours of substances which have high and known boiling-points. The apparatus employed by them for this purpose is applicable at any temperature up to 1040° ; but, for temperatures up to 440° , the highest point at which glass globes can be used without fear of softening, the simpler apparatus proposed by Greville Williams‡ is all that is required. For a temperature of 350° the globe is heated in the vapour of boiling mercury, and for a temperature of 440° boiling sulphur is employed. For higher temperatures the more elaborate apparatus of Deville and Troost must be employed with porcelain globes. A temperature of 860° is obtained by heating the globe in the vapour of boiling cadmium, and by replacing the cadmium by zinc we obtain a temperature of 1040° . In these cases the details and formulæ are the same as in the ordinary Dumas' method; the following data will facilitate the calculation:—

* Regnault, *Cours Elementaire de Chimie*, 4, 71.

† *Ann. Chim. Phys.*, 3rd Series, 58, 257.

‡ *Watts' Dict. Chem.*, 5, 374.

T	α	$\log \alpha$	β	$\log \beta$
350	0 00000074483	$\overline{7}$ ·8720609	1·0109	0·0047082
440	65074	8134136	1·0131	56523
860	40940	6121557	1 0091*	39213
1040	35325	5480935	1·0110	47555

A very useful modification of Dumas' method has been proposed by Grabowski†, as, although it necessitates the employment of a thermometer of some description, it is not necessary that it be correctly graduated, as the only thing requisite is that the oil-bath be heated to the same temperature (whatever it may be) during both parts of the operation, which is conducted as follows:—A glass globe is weighed full of dry air at the atmospheric temperature and pressure; it is then heated in an oil-bath, and the position of the mercury in the thermometer is registered; it is then sealed, cooled, and weighed. The point is then cut off, and the globe is weighed again, in order to determine the weight of glass lost in opening the point. The substance is then introduced and the globe is heated to the same temperature as before, and is then sealed, cooled, and weighed. Then if the atmospheric temperature (t) and pressure (H) have been the same throughout,

and if V = volume of globe,

and P = weight of globe at first weighing,

P' = " second "

P'' = " third "

P''' = " fourth "

$$D = \frac{P''' - P'' + V \frac{0\cdot0012932}{760(1 + 0\cdot00367t)} H}{P' - P + V \frac{0\cdot0012932}{760(1 + 0\cdot00367t)} H}$$

$$= \frac{P''' - P'' + V \alpha H}{P' - P + V \alpha H}$$

The following method, proposed by Deville and Troost‡, renders the calculation of the result as simple as in the preceding case, but has the advantage of not requiring any thermometer. By the side of the globe in which the substance is being heated a globe, of as nearly as possible the same size, containing air or iodine is placed; the two globes are then

* The mean co-efficient of expansion of porcelain is 0·0000108.

† Loc. cit.

‡ Comptes Rendus, 56, 891.

sealed at the same time, cooled and weighed (at temperature t and pressure H); then if

- P = weight of the globe in which the substance is to be heated,
 P' = weight after sealing of globe containing substance,
 P'' = weight of globe to be used for air or iodine,
 P''' = weight after sealing of globe containing air or iodine,
 V = volume of globe containing substance,
 V' = volume of globe containing air or iodine;

and if air be used as the standard,

$$D = \frac{(P' - P + V \frac{0.0012932}{760(1+0.00367t)}H)V'}{(P''' - P'' + V' \frac{0.0012932}{760(1+0.00367t)}H)V} = \frac{(P' - P + V \alpha H)V'}{(P''' - P'' + V' \alpha H)V}$$

and in the case of iodine being used—

$$D = 8.716 \frac{(P' - P + V \alpha H)V'}{(P''' - P'' + V' \alpha H)V}$$

This formula cannot be used if there is much residual air in either of the globes; in that case it is necessary to determine T with the ordinary Dumas' formula by means of the iodine globe, substituting for D its value 8.716. After determining T , the vapour-density of the substance is found by means of the complete Dumas' formula already given. In this method mercury cannot be substituted for iodine, as it condenses in the neck of the globe, and the cold drops fall back into the hot globe, and in so doing are very liable to break it.

Regnault's* method for accomplishing the same object is available only where the boiling-point of the substance is high, and a large quantity can be obtained for the experiment, as there is no means of determining the residual air. The apparatus consists of two iron bottles, of nearly the same capacity, whose necks are partially closed by imperfectly-fitting stoppers; in one of these the substance is heated in a muffle, and in the other, which is heated at the same time, some mercury is placed before heating. They are then withdrawn and allowed to cool and the amounts left in the two flasks are determined by dissolving out the substances and estimating the quantities by appropriate means.

* Ann. Chim. Phys. 3rd Series, 63, 45.

Then if P = weight of mercury found,
 P' = weight of substance found,
 V = volume of flask in which mercury was heated,
 V' = volume of flask in which substance was heated,

$$D = 6.9 \frac{P' V}{P V'}$$

In Regnault's* method, in which the air-thermometer is employed, it is not necessary to know the temperature at the time of sealing, as the weight of the vapour is compared with the weight of the volume of air which has been heated at the same time. With reference to the globe containing the substance, the following letters, viz., P , H , V , and t , have the same meanings as in the Dumas' formula.

Then if W' = weight of mercury which completely fills the air-thermometer at 0° ,

W = weight of mercury which has entered the air-thermometer after it has been cooled down to 0° , and the point has been opened,

h = height of mercury in air-thermometer above the level of the cistern,

$$D = \frac{P + V \frac{0.0012932}{760 (1 + 0.00367t)} H}{\frac{W' - W}{W'} V \frac{0.0012932}{760} (H - h)}$$

$$= \frac{P + V a H}{\frac{W' - W}{W'} V a (H - h)}$$

Playfair and Wanklyn's† method, which has the advantage of being applicable in the case of liquids which decompose on being heated, is so complicated in its details that a condensed formula is impossible; we must therefore refer the reader to the original paper.

* Regnault, Cours Elementaire de Chimie, 4, 63.

† Trans. Roy. Soc. Edin., *loc. cit.*

$$\frac{0.0012932}{760 (1 + 0.00367 t)} = a$$

t.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0	0.00000170157	0095	0033	*9970	9908	9846	9784	9721	9659	9597
1	169535	9473	9411	9349	9288	9226	9164	9102	9041	8979
2	8918	8856	8795	8733	8672	8610	8549	8488	8427	8365
3	8304	8243	8182	8121	8060	7999	7939	7878	7817	7756
4	7696	7635	7574	7514	7453	7393	7332	7272	7212	7152
5	7091	7031	6971	6911	6.51	6791	6731	6671	6611	6551
6	6491	6431	6372	6312	6252	6193	6133	6074	6014	5955
7	5896	5836	5777	5718	5658	5599	5540	5481	5422	5363
8	5304	5245	5186	5127	5069	5010	4951	4893	4834	4775
9	4717	4658	4600	4541	4483	4425	4366	4308	4250	4192
10	4134	4076	4018	3960	3902	3844	3786	3728	3670	3612
11	3555	3497	3439	3382	3324	3267	3209	3152	3094	3037
12	2980	29.2	2865	2808	2751	2694	2637	2580	2523	2466
13	2409	2352	22.5	2238	2182	2125	2068	2012	1955	1898
14	1842	1785	1729	1673	1616	1560	1504	1447	1391	1335
15	1279	1223	1167	1111	1055	9999	9943	9887	9831	9776
16	0720	0664	0609	0553	0497	0442	0386	0331	0275	0220
17	0165	0109	0054	*9999	9944	9889	9833	9778	9723	9668
18	159613	9558	9503	9449	9394	9339	9284	9230	9175	9120
19	9066	9011	8957	8902	8848	8793	8739	8685	8630	8576
20	8522	8468	8414	8359	8305	8251	8197	8143	8089	8036
21	7982	7928	7874	7820	7767	7713	7659	7606	7552	7499
22	7445	7392	7338	7285	7232	7178	7125	7072	7019	6966
23	6912	6859	6806	6753	6700	6647	6594	6542	6489	6436
24	6383	6330	6278	6225	6172	6120	6067	6015	5962	5910
25	5857	5805	5753	5700	5648	5596	5544	5492	5439	5387
26	5335	5283	5231	5179	5127	5075	5024	4972	4920	4868
27	4817	4765	4713	4662	4610	4559	4507	4456	4404	4353
28	4301	4250	4199	4147	4096	4045	3994	3943	3892	3841
29	3790	3739	3688	3637	3586	3535	3484	3433	3383	3332

$$\text{Log.} \frac{0.0012932}{760 (1 + 0.00367 t)} = \text{log. } a.$$

t.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0	6 230852	0692	0533	0374	0215	0056	*9896	9737	9579	9420
1	229261	9102	8943	8785	8626	8467	8309	8151	7992	7834
2	7676	7517	7359	7201	7043	6885	6727	6569	6412	6254
3	6096	5939	5781	5624	5466	5309	5151	4994	4837	4680
4	4523	4366	4209	4052	3895	3738	3581	3424	3268	3111
5	2955	2798	2642	2485	2329	2173	2017	1860	1704	1548
6	1.92	1236	1080	0925	0769	0613	0458	0302	0146	*9991
7	21 835	96.0	9525	9370	9214	9059	8904	8749	8594	8439
8	8284	8130	7975	7820	7666	7511	7356	7202	7047	6893
9	6739	6584	6430	6276	6122	5968	5814	5660	5506	5352
10	5199	5045	4891	4738	4584	4431	4277	4124	3970	3817
11	3664	3511	3358	3204	3051	2898	2746	2593	2440	2287
12	2135	1982	1829	1677	1524	1372	1220	1067	0915	0763
13	0611	0458	0306	0154	0002	*9851	9699	9547	9395	9244

$$\text{Log.} \frac{0.0012932}{760 (1 + 0.00367 t)} = \log. \alpha.$$

t.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
14	6.209092	8940	8789	8637	8486	8335	8183	8032	7881	7730
15	7579	7428	7277	7126	6975	6824	6673	6522	6372	6221
16	6071	5920	5770	5619	5469	5318	5168	5018	4868	4718
17	4568	4418	4268	4118	3968	3818	3668	3519	3369	3220
18	3070	2921	2771	2622	2472	2323	2174	2025	1876	1726
19	1577	1428	1280	1131	0982	0833	0684	0536	0387	0239
20	0090	*9942	9793	9645	9496	9348	9200	9052	8904	8756
21	198608	84.0	8312	8164	8016	7868	7721	7573	7425	7278
22	7130	6983	6836	6688	6541	6394	6246	6099	5952	5805
23	5658	5511	5364	5217	5071	4924	4777	4631	4484	4337
24	4191	4044	3898	3752	3605	3459	3313	3167	3021	2875
25	2728	2583	2437	2291	2145	1999	1853	1708	1562	1417
26	1271	1126	0980	0835	0689	0544	0399	0254	0109	*9963
27	189818	9673	9529	9384	9239	9094	8949	8804	8660	8515
28	8371	8226	8082	7937	7793	7649	7504	7360	7216	7072
29	6928	6784	6640	6496	6352	6208	6064	5921	5777	5633

$$\text{Log.} \frac{0.0012932}{760 (1 + 0.00367 T)} = \log. \alpha.$$

T.	Log. α.	Diff.	T.	Log. α.	Diff.	T.	Log. α.	Diff.
30	6.185490	718	44.5	6.165154	684	68	6.134095	1274
30.5	184772	716	45	164470	684	69	132821	1270
31	184056	715	45.5	163786	682	70	131551	1266
31.5	183341	714	46	163114	681	71	130285	1263
32	182627	712	46.5	162423	681	72	129022	1259
32.5	181915	712	47	161742	679	73	127763	1255
33	181203	710	47.5	161063	678	74	126508	1252
33.5	180493	709	48	160385	677	75	125256	1248
34	179784	708	48.5	159708	676	76	124008	1244
34.5	179076	707	49	159032	675	77	122764	1241
35	178369	705	49.5	158357	674	78	121523	1237
35.5	177664	705	50	157683	1344	79	120286	1234
36	176959	703	51	156939	1341	80	119052	1231
36.5	176256	702	52	156198	1336	81	117821	1227
37	175554	701	53	155462	1332	82	116594	1223
37.5	174853	700	54	154730	1329	83	115371	1220
38	174153	699	55	154001	1324	84	114151	1217
38.5	173454	698	56	153277	1320	85	112934	1213
39	172756	697	57	152557	1316	86	111721	1210
39.5	172059	695	58	151841	1312	87	110511	1206
40	171364	694	59	151129	1308	88	109305	1203
40.5	170670	694	60	150421	1305	89	108102	1200
41	169976	692	61	149716	1300	90	106902	1196
41.5	169284	691	62	149016	1.96	91	105706	1194
42	168593	690	63	148320	1293	92	104512	1189
42.5	167903	689	64	147627	1289	93	103323	1187
43	167214	687	65	146938	1285	94	102136	1184
43.5	166527	687	66	146253	1281	95	100952	1180
44	165840	686	67	145572	1277	96	099772	1177

$$\text{Log. } \frac{0.0012932}{760(1 + 0.00367 T)} = \text{log. } \alpha.$$

T.	Log. α .	Diff.	T.	Log. α .	Diff.	T.	Log. α .	Diff.
97	$\bar{6}.098595$	1174	151	$\bar{6}.039353$	1024	205	$\bar{7}.987231$	909
98	097421	1170	152	038329	1022	206	986322	906
99	096251	1168	153	037307	1020	207	985416	905
100	095083	1164	154	036287	1017	208	984511	903
101	093919	1161	155	035270	1015	209	983608	901
102	092758	1159	156	034255	1012	210	982707	900
103	091599	1155	157	033243	1010	211	981807	897
104	090444	1152	158	032233	1008	212	980910	895
105	089292	1149	159	031225	1005	213	980015	894
106	088143	1146	160	030220	1003	214	979121	892
107	086997	1143	161	029217	1001	215	978229	890
108	085854	1140	162	028216	998	216	977339	888
109	084714	1137	163	027218	996	217	976451	886
110	083577	1134	164	026222	994	218	975565	885
111	082443	1131	165	025228	992	219	974680	883
112	081312	1128	166	024236	989	220	973797	881
113	080184	1125	167	023247	987	221	972916	879
114	079059	1122	168	022260	985	222	972037	877
115	077937	1120	169	021275	983	223	971160	876
116	076817	1116	170	020292	980	224	970284	874
117	075701	1114	171	019312	978	225	969410	872
118	074587	1111	172	018334	976	226	968538	870
119	073476	1107	173	017358	974	227	967668	869
120	072369	1106	174	016384	972	228	966799	867
121	071263	1102	175	015412	269	229	965932	865
122	070161	1099	176	014443	267	230	965067	863
123	069062	1097	177	013476	266	231	964204	862
124	067965	1094	178	012510	963	232	963342	860
125	066871	1091	179	011547	960	233	962482	858
126	065780	1089	180	010587	959	234	961624	857
127	064691	1086	181	009628	957	235	960767	855
128	063605	1083	182	008671	954	236	959912	853
129	062522	1080	183	007717	953	237	959059	852
130	061442	1078	184	006764	950	238	958207	850
131	060364	1075	185	005814	948	239	957357	848
132	059289	1072	186	004866	947	240	956509	847
133	058217	1070	187	003919	944	241	955662	845
134	057147	1067	188	002975	942	242	954817	843
135	056080	1065	189	002033	940	243	953974	842
136	055015	1062	190	001093	938	244	953132	840
137	053953	1059	191	000155	936	245	952292	838
138	052894	1057	192	$\bar{7}.999219$	934	246	951454	837
139	051837	1054	193	998285	932	247	950617	835
140	050783	1051	194	997353	930	248	949782	834
141	049732	1050	195	996423	928	249	948948	832
142	048682	1046	196	995495	926	250	948116	830
143	047636	1044	197	994569	924	251	947286	829
144	046592	1042	198	993645	922	252	946457	827
145	045550	1039	199	992723	920	253	945630	826
146	044511	1036	200	991803	919	254	944804	824
147	043475	1034	201	990884	916	255	943980	823
148	042441	1032	202	989968	914	256	943157	821
149	041409	1029	203	989054	913	257	942336	819
150	040380	1027	204	988141	910	258	941517	818

$$\text{Log. } \frac{0.0012932}{760 (1 + 0.00367 T)} = \text{log. } \alpha.$$

T.	Log. α	Diff.	T.	Log. α	Diff.	T.	Log. α	Diff.
259	$\bar{7} \cdot 940699$	816	273	$\bar{7} \cdot 929407$	795	287	$\bar{7} \cdot 918401$	775
260	939883	815	274	928612	794	288	917626	774
261	939068	814	275	927818	793	289	916852	773
262	938254	811	276	927025	791	290	916079	772
263	937443	811	277	926234	790	291	915307	770
264	936632	808	278	925444	788	292	914537	768
265	935824	808	279	924656	787	293	913769	768
266	935016	805	280	923869	785	294	913001	766
267	934211	805	281	923084	784	295	912235	764
268	933406	802	282	922300	782	296	911471	764
269	932604	802	283	921518	782	297	910707	762
270	931802	800	284	920736	779	298	909945	760
271	931002	798	285	919957	779	299	909185	759
272	930204	797	286	919178	777	300	908426	

$$\frac{0.0012932}{760(1 + 0.00367t)} H = \alpha H$$

H	t	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	H
10	0.0012063	080	096	113	129	145	162	178	195	211	227	244	260	277	293	310	326	342	358	10
10.5	0.42	058	075	091	108	124	140	157	173	190	206	222	239	255	271	288	304	321	337	10.5
11	0.21	037	054	070	086	103	119	135	152	168	184	201	217	233	250	266	282	299	315	11
11.5	0.00	016	032	049	065	081	098	114	130	147	163	179	196	212	228	245	261	277	293	11.5
12	0.0011979	995	*011	027	044	060	076	093	109	125	142	158	174	190	207	223	239	256	272	12
12.5	0.958	974	990	*006	023	039	055	071	088	104	120	136	153	169	185	202	218	234	250	12.5
13	937	963	969	985	*002	018	034	050	067	083	099	115	131	148	164	180	196	213	229	13
13.5	916	932	948	964	981	997	*013	029	045	062	078	094	110	126	143	159	175	191	207	13.5
14	895	911	927	943	960	976	992	*008	024	041	057	073	089	105	121	138	154	170	186	14
14.5	874	890	907	923	939	955	971	987	*003	020	036	052	068	084	100	117	133	149	165	14.5
15	854	870	886	902	918	934	950	966	983	999	*015	031	047	063	079	095	112	128	144	15
15.5	833	849	865	881	897	913	930	946	962	978	994	*010	026	042	058	074	091	107	123	15.5
16	812	829	845	861	877	893	909	925	941	957	973	989	*005	021	037	054	070	086	102	16
16.5	792	808	824	840	856	872	888	904	920	936	952	968	985	*001	017	033	049	065	081	16.5
17	772	788	804	820	836	852	868	884	900	916	932	948	964	980	996	*012	028	044	060	17
17.5	751	767	783	799	815	831	847	863	879	895	911	927	943	959	975	991	*007	023	039	17.5
18	731	747	763	779	795	811	827	843	859	875	891	907	923	939	955	971	986	*002	018	18
18.5	711	727	743	759	775	791	807	822	838	854	870	886	902	918	934	950	966	982	998	18.5
19	691	707	723	739	754	770	786	802	818	834	850	866	882	898	914	929	945	961	977	19
19.5	571	587	603	619	635	651	667	683	699	715	731	747	763	779	795	811	827	843	859	19.5
20	651	667	683	698	714	730	746	762	778	794	809	825	841	857	873	889	905	920	936	20
20.5	631	647	663	678	694	710	726	742	758	773	789	805	821	837	853	868	884	900	916	20.5
21	611	627	643	659	674	690	706	722	738	753	769	785	801	817	832	848	864	880	896	21
21.5	591	607	623	639	655	670	686	702	718	733	749	765	781	796	812	828	844	860	876	21.5
22	572	588	603	619	635	650	666	682	698	713	729	745	761	776	792	808	824	839	855	22
22.5	552	568	584	599	615	631	646	662	678	694	709	725	741	756	772	788	804	819	835	22.5
23	533	548	564	580	595	611	627	642	658	674	690	705	721	737	752	768	784	799	815	23
23.5	513	529	544	560	576	591	607	623	638	654	670	685	701	717	732	748	764	779	795	23.5
24	494	509	525	541	556	572	588	603	619	634	650	666	681	697	713	728	744	760	776	24
24.5	474	490	506	521	537	552	568	584	599	615	630	646	662	677	693	709	724	740	756	24.5
25	455	471	486	502	517	533	549	564	580	595	611	627	642	658	673	689	704	720	735	25

$$\frac{H}{760} \frac{0.0012932}{(1 + 0.00367t)} = \alpha H$$

H	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	H
t																		t	
10	0.0012359	375	392	408	424	441	457	474	490	507	523	539	556	572	589	605	621	638	10
10.5	337	353	370	386	403	419	435	452	468	484	501	517	534	550	566	583	599	616	10.5
11	315	332	348	364	381	397	413	430	446	462	479	495	511	528	544	561	577	593	11
11.5	294	310	326	343	359	375	391	408	424	440	457	473	489	506	522	538	555	571	11.5
12	272	288	305	321	337	353	370	386	402	419	435	451	467	484	500	516	533	549	12
12.5	250	267	283	299	315	332	348	364	381	397	413	429	446	462	478	494	511	527	12.5
13	229	245	261	278	294	310	326	343	359	375	391	408	424	440	456	473	489	505	13
13.5	208	224	240	256	272	289	305	321	337	353	370	386	402	418	435	451	467	483	13.5
14	186	202	219	235	251	267	283	300	316	332	348	364	380	397	413	429	445	461	14
14.5	165	181	197	213	230	246	262	278	294	310	327	343	359	375	391	407	423	440	14.5
15	144	160	176	192	208	224	241	257	273	289	305	321	337	354	370	386	402	418	15
15.5	123	139	155	171	187	203	219	235	252	268	284	300	316	332	348	364	380	396	15.5
16	102	118	134	150	166	182	198	214	230	246	262	279	295	311	327	343	359	375	16
16.5	81	97	113	129	145	161	177	193	209	225	241	257	273	289	305	321	338	354	16.5
17	60	76	92	108	124	140	156	172	188	204	220	236	252	268	284	300	316	332	17
17.5	39	55	71	87	103	119	135	151	167	183	199	215	231	247	263	279	295	311	17.5
18	018	34	50	66	82	98	114	130	146	162	178	194	210	226	242	258	274	290	18
18.5	0011908	*014	030	046	062	077	093	109	125	141	157	173	189	205	221	237	253	269	18.5
19	977	993	*009	025	041	057	073	089	104	120	136	152	168	184	200	216	232	248	19
19.5	957	973	988	001	020	036	052	068	084	100	115	131	147	163	179	195	211	227	19.5
20	936	952	968	984	*000	015	031	047	063	079	095	111	126	142	158	174	190	206	20
20.5	916	932	948	963	979	995	*011	027	042	058	074	090	106	122	137	153	169	185	20.5
21	896	911	927	943	959	975	990	*006	022	038	054	069	085	101	117	133	149	164	21
21.5	875	891	907	923	938	954	970	986	*001	017	033	049	065	080	096	112	128	143	21.5
22	855	871	887	902	918	934	950	965	981	997	*013	028	044	060	076	091	107	123	22
22.5	835	851	867	882	898	914	929	945	961	977	*008	024	039	055	071	087	102	118	22.5
23	815	831	846	862	878	893	909	925	941	956	972	988	*003	019	035	050	066	082	23
23.5	795	811	826	842	858	873	889	905	920	936	952	967	983	999	*014	030	046	061	23.5
24	775	791	806	822	838	853	869	885	900	916	932	947	963	978	994	*010	026	041	24
24.5	755	771	787	802	818	833	849	865	880	896	911	927	943	958	974	990	*005	021	24.5
25	736	751	767	782	798	814	829	845	860	876	891	907	923	938	954	969	985	*001	25

$$\text{Log.} \left(H \frac{0.0012932}{760 (1 + 0.00367t)} \right) = \text{Log. } \alpha H.$$

H	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	H
Log. H	2.866237	6377	7467	8056	8644	9231	9818	*0403	0988	1572	2156	2738	3320	3901	4481	5061	5639	6217	Log. H
t																			t
10	5	2076	2666	3255	3843	4430	5017	5602	6187	6771	7355	7937	8519	9100	9680	*0260	0833	1416	10
10	5	1308	1898	2487	3075	3662	4249	4834	5419	6003	6587	7169	7751	8332	8912	9492	*0070	0648	10
11	11	079951	*0542	1131	1730	2308	2896	3482	4068	4653	5237	5820	6403	6984	7565	8146	8725	9304	11
11	5	9186	9776	*0366	0955	1543	2130	2717	3302	3887	4471	5055	5637	6219	6800	7380	7960	8538	11
12	12	9452	9902	*0191	0779	1366	1953	2538	3123	3707	4291	4873	5455	6036	6616	7196	7774	8352	12
12	5	7659	8250	8839	9428	*0016	0604	1190	1776	2361	2945	3528	4111	4692	5273	5851	6433	7012	12
13	13	6898	7488	8078	8667	9255	9842	*0429	1014	1599	2183	2767	3349	3931	4512	5092	5672	6250	13
13	5	6138	6728	7318	7907	8495	9082	*0265	0859	1424	2007	2589	3171	3752	4332	4912	5491	6068	13
14	14	5379	5970	6559	7148	7736	8324	8910	9496	*0081	0665	1248	1831	2413	2994	3574	4153	4732	14
14	5	4622	5212	5802	6391	6979	7566	8153	8738	9323	9907	*0491	1073	1655	2236	2816	3396	3974	14
15	15	3862	4456	5046	5635	6223	6810	7397	7982	8567	9151	9735	*0317	0899	1480	2060	2640	3218	15
15	5	3111	3702	4291	4880	5468	6056	6642	7228	7813	8397	8980	9563	*0145	0726	1306	1885	2464	15
16	16	2358	2948	3538	4127	4715	5302	5889	6474	7059	7643	8227	8809	9391	9972	*0552	1132	1710	16
16	5	1606	2196	2786	3375	3963	4550	5137	5722	6307	6891	7475	8057	8639	9220	9800	*0380	0958	16
17	17	0855	1445	2035	2624	3212	3799	4386	4972	5556	6141	6724	7306	7888	8469	9049	9629	*0208	17
17	5	0105	0696	1286	1875	2463	3050	3636	4222	4807	5391	5974	6557	7139	7720	8300	8879	9458	17
18	18	069357	9948	*0538	1126	1714	2302	2888	3474	4059	4643	5226	5809	6391	6972	7552	8131	8710	18
18	5	8610	9201	9791	*0379	0967	1555	2141	2727	3312	3896	4479	5062	5644	6225	6805	7384	7963	18
19	19	7865	8455	9045	*0222	0809	1396	1981	2566	3150	3734	4316	4898	5479	6059	6639	7217	7795	19
19	5	7120	7711	8301	8890	*0494	1081	1663	2246	2829	3411	3992	4572	5151	5730	6308	6884	7459	19
20	20	6377	6968	7558	8146	8734	9322	9908	*0494	1079	1663	2246	2829	3411	3992	4572	5151	5730	20
20	5	5686	6226	6816	7405	7993	8580	9166	9752	*0337	0921	1505	2087	2669	3250	3830	4410	4988	20
21	21	4156	4746	5336	5925	6513	7100	7687	8272	8857	9441	*0025	0607	1189	1770	2350	2930	3508	21
21	5	3418	4008	4598	5187	5775	6362	6949	7534	8119	8703	9287	9869	*0451	1032	1612	2192	2770	21
22	22	2681	3271	3861	4450	5038	5625	6212	6798	7382	7967	8550	9132	9714	*0295	0875	1455	2034	22
22	5	1945	2536	3126	3715	4303	4890	5476	6062	6647	7231	7814	8397	8979	9560	*0140	0719	1298	22
23	23	1211	1802	2391	2980	3568	4156	4742	5328	5913	6497	7080	7663	8244	8825	9406	9985	*0564	23
23	5	0478	1069	1658	2247	2835	3423	4009	4595	5180	5764	6347	6930	7511	8092	8673	9252	9831	23
24	24	058746	0327	0927	1515	2103	2691	3277	3863	4448	5032	5615	6198	6780	7361	7941	8520	9099	24
24	5	9016	9606	*0196	0785	1373	1960	2547	3132	3717	4301	4885	5467	6049	6630	7210	7790	8368	24
25	25																		25

$$\text{Log. } \left(H \frac{0.0012332}{760(1 + 0.00367t)} \right) = \text{Log. } \alpha H.$$

H	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	H
Log. H	2.876795	7371	7947	8521	9095	9669	*0241	0813	1384	1955	2524	3093	3661	4228	4795	5361	5926	6490	Log. H
t																			t
10	3.091994	2570	3146	3720	4294	4868	5440	6012	6583	7154	7723	8292	8860	9427	9994	*0560	1125	1689	10
10.5	1.226	1802	2378	2952	3526	4100	4672	5244	5815	6386	6955	7524	8092	8659	9226	9792	*0357	0921	10.5
11	0.459	1035	1611	2185	2760	3333	3906	4477	5049	5619	6188	6757	7325	7893	8459	9025	9590	*0155	11
11.5	*089693	*0270	0845	1420	1994	2568	3140	3712	4283	4853	5423	5992	6560	7127	7694	8260	8825	9389	11.5
12	8930	9506	*0082	0656	1230	1804	2376	2948	3519	4090	4659	5228	5796	6363	6930	7496	8061	8625	12
12.5	8167	8743	9319	9894	*0468	1041	1614	2185	2757	3327	3896	4465	5033	5601	6167	6733	7298	7863	12.5
13	7406	7982	8558	9132	9706	*0280	0852	1424	1995	2566	3135	3704	4272	4839	5406	5972	6537	7101	13
13.5	6646	7222	7798	8372	8947	9520	*0092	0664	1235	1806	2375	2944	3512	4079	4646	5212	5777	6341	13.5
14	5887	6463	7039	7614	8188	8761	9334	9906	*0477	1047	1616	2185	2753	3321	3887	4453	5018	5583	14
14.5	5130	5705	6282	6856	7430	8004	8576	9148	9719	*0290	0859	1428	1996	2563	3130	3696	4261	4825	14.5
15	4374	4950	5526	6100	6674	7248	7820	8392	8963	9534	*0103	0672	1240	1807	2374	2940	3505	4069	15
15.5	3619	4195	4771	5346	5920	6493	7066	7638	8209	8779	9348	9917	*0485	1053	1619	2185	2750	3315	15.5
16	2866	3442	4018	4592	5166	5740	6312	6881	7455	8026	8595	9164	9732	*0299	0866	1432	1997	2561	16
16.5	2113	2690	3265	3840	4414	4988	5560	6132	6703	7273	7843	8412	8980	9547	*0114	0680	1245	1809	16.5
17	1363	1939	2515	3089	3664	4237	4809	5381	5952	6523	7092	7661	8229	8796	9363	9929	*0494	1058	17
17.5	0613	1189	1765	2340	2914	3487	4060	4632	5203	5773	6343	6912	7480	8047	8614	9179	9744	*0309	17.5
18	*07865	*0441	1017	1592	2166	2739	3312	3884	4455	5025	5595	6163	6731	7299	7865	8431	8996	9561	18
18.5	9118	9694	*0270	0845	1419	1992	2565	3137	3708	4278	4848	5416	5984	6552	7118	7684	8249	8814	18.5
19	8372	8949	9524	*0099	0673	1247	1819	2391	2962	3532	4102	4671	5239	5806	6373	6939	7504	8068	19
19.5	7628	8204	8780	9355	9929	*0502	1075	1647	2218	2788	3358	3927	4495	5062	5629	6194	6759	7324	19.5
20	6885	7461	8037	8612	9186	9759	*0332	0904	1475	2045	2615	3183	3751	4319	4885	5451	6016	6581	20
20.5	6143	6720	7295	7870	8444	9017	9590	*0162	0733	1303	1873	2442	3010	3577	4144	4709	5275	5839	20.5
21	5403	5979	6555	7130	7704	8277	8850	9421	9992	*0563	1132	1701	2269	2837	3403	3969	4534	5098	21
21.5	4663	5240	5815	6390	6964	7538	8110	8682	9253	9823	*0393	0962	1530	2097	2664	3230	3795	4359	21.5
22	3925	4502	5077	5652	6226	6800	7372	7944	8515	9085	9655	*0224	0792	1359	1926	2492	3057	3621	22
22.5	3189	3765	4341	4915	5490	6063	6635	7207	7778	8349	8918	9487	*0055	0622	1189	1755	2320	2884	22.5
23	2453	3029	3605	4180	4754	5327	5900	6472	7043	7613	8183	8752	9320	9887	*0454	1019	1584	2140	23
23.5	1719	2295	2871	3446	4020	4593	5166	5737	6309	6879	7448	8017	8585	9153	9719	*0285	0850	1415	23.5
24	0986	1562	2138	2713	3287	3860	4433	5004	5576	6146	6715	7284	7852	8420	8986	9552	*0117	0682	24
24.5	0254	0830	1406	1981	2555	3128	3701	4273	4844	5414	5984	6552	7120	7688	8254	8820	9385	9950	24.5
25	*069523	*0100	0675	1250	1824	2398	2970	3542	4113	4683	5253	5822	6390	6957	7524	8090	8655	9219	25

$$\log. (1 + k (T-t)) = \log. \beta.$$

$(T-t.)$	$\log. \beta.$	$(T-t.)$	$\log. \beta.$	$(T-t.)$	$\log. \beta.$
35	0·000416	125	0·001539	215	0·002770
40	477	130	599	220	835
45	538	135	699	225	900
50	599	140	764	230	964
55	655	145	824	235	0·003111
60	716	150	889	240	176
65	776	155	954	245	240
70	837	160	0·002014	250	309
75	898	165	079	255	374
80	954	170	140	260	439
85	0·001045	175	205	265	503
90	106	180	265	270	572
95	166	185	386	275	637
100	231	190	451	280	701
105	292	195	516	285	856
110	353	200	580	290	921
115	413	205	641	295	990
120	474	210	706	300	0·004059

$$\frac{1 + 0·00367 T}{1 + 0·00367 t} = \gamma.$$

	$t. 0$	5	10	15	20	25	30
T.							
50	1·183	1·162	1·141	1·121	1·102	1·084	1·066
55	201	180	159	139	119	100	082
60	220	198	177	156	136	117	099
65	238	216	194	173	153	134	115
70	256	234	212	191	170	151	132
75	275	252	230	208	188	168	148
80	293	270	247	226	205	184	165
85	311	288	265	243	222	201	181
90	330	306	283	260	239	218	198
95	348	324	300	278	256	235	214
100	367	342	318	295	273	252	231
105	385	360	336	313	290	268	247
110	403	378	354	330	307	285	264
115	422	396	371	347	324	302	281
120	440	414	389	365	341	319	297
125	458	432	407	382	359	336	314
130	477	450	424	400	376	352	330
135	495	468	442	417	393	369	347
140	513	486	460	434	410	386	363
145	532	504	477	452	427	403	380
150	550	522	495	469	444	420	396
155	568	540	513	487	461	437	413
160	587	558	531	504	478	453	429
165	605	576	548	521	495	470	446
170	623	594	566	539	512	487	462
175	642	612	584	556	529	504	479

$$\frac{1 + 0.00367 T}{1 + 0.00367 t} = \gamma.$$

	<i>t.</i> 0	5	10	15	20	25	30
T.							
180	1.660	1.630	1.601	1.573	1.547	1.521	1.495
185	678	648	619	591	564	537	512
190	697	666	637	608	581	554	528
195	715	684	654	626	598	571	545
200	734	702	672	643	615	588	562
205	752	720	690	660	632	605	578
210	770	738	708	678	649	621	595
215	789	756	725	695	666	638	611
220	807	774	743	713	683	655	628
225	825	792	761	730	700	672	644
230	844	810	778	747	718	689	661
235	862	828	796	765	735	705	677
240	880	846	814	782	752	722	694
245	899	864	831	800	769	739	710
250	917	882	849	817	786	756	727
255	935	900	867	834	803	773	743
260	954	918	885	852	820	789	760
265	972	937	902	869	837	806	776
270	990	955	920	887	854	823	793
275	2.009	973	938	904	871	840	809
280	027	991	955	921	888	857	826
285	045	2.009	973	939	906	874	843
290	064	027	991	956	923	890	859
295	082	045	2.008	973	940	907	876
300	101	063	026	991	957	924	892
305	119	081	044	2.008	974	941	909
310	137	099	062	026	991	958	925
315	156	117	079	043	2.008	974	942
320	174	135	097	060	025	991	958
325	192	153	115	078	042	2.008	975
330	211	171	132	095	059	025	991
335	229	189	150	113	077	042	2.008
340	247	207	168	130	094	058	024
345	266	225	185	147	111	075	041
350	284	243	203	165	128	092	057