A graphical method for the rapid correction of specific gravity determinations.

(*With Plate IV.*)

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It has long been recognized that if specific gravity determinations are to be accurate to a unit or two of the third decimal place corrections must be applied for the error due to the circumstances (i) that the weighings are made in air instead of in a vacuum, and (ii) that the temperature at which the determinations are made usually differs considerably from the standard temperature of 4° C.

The value of the corrected specific gravity S referred to water at 4° C. can be found by means of the expression[1]

$$S = S'(D-\sigma) + \sigma,$$

where S' is the uncorrected specific gravity, D is the density of water at the temperature t° at which the weighings were made, and σ is the weight of 1 c.c. of air, which may be taken with sufficient accuracy to be 0·0012 gram.

The following cases commonly present themselves:

1. The specific gravity is determined by the Archimedean method of weighing, first in air and afterwards in water at a temperature t°,

$$\text{when } S' = \frac{\text{weight of solid in air}}{\text{loss of weight in water}}.$$

2. The specific gravity of a liquid is determined by the pyknometer method,

$$\text{when } S' = \frac{\text{weight of liquid filling pyknometer at } t^{\circ}}{\text{weight of water filling pyknometer at } t^{\circ}}.$$

[1] The method of arriving at this formula is discussed in the text-books, e.g. W. Watson, 'A text-book of Practical Physics', or F. Kohlrausch, 'Leitfaden der praktischen Physik'. For an account of the precautions necessary in accurate work reference should be made to A. E. H. Tutton, 'Crystallography and Practical Crystal Measurement', 2nd edit., 1922, vol. 1, chap. xxxii, and also to a recent paper by A. C. Egerton and W. B. Lee, Proc. R. Soc. London, 1923, ser. A, vol. 103, p. 487, where other references will be found. The values of D have been taken from the tables of Landolt and Börnstein, 2nd edit., 1894, p. 39.

3. The suspension method is used for finding the specific gravity of a solid by means of a mixture of liquids, the specific gravity of the mixture being found by weighing a sinker, first in the mixture and then in water,

$$\text{when } S' = \frac{\text{loss of weight of sinker in mixture at } t^\circ}{\text{loss of weight of sinker in water at } t^\circ}.$$

4. The specific gravity of a solid is determined by the pyknometer,

$$\text{when } S' = \frac{\text{weight of solid in air}}{\text{weight of water at } t^\circ \text{ displaced by the solid}}.$$

If, in this last case, a liquid other than water, say carbon tetrachloride, is used to fill the pyknometer, then in order to obtain S', the uncorrected specific gravity of the solid, the number got by dividing the weight of the solid by the weight of the liquid displaced by it must be multiplied by the uncorrected specific gravity of the liquid as found by methods 2 or 3.

On looking at the expression $S = S'(D - \sigma) + \sigma$ it will be noticed that when $S' = 1$, the correction depends on the temperature term D only, while for any given temperature t° the correction increases as S' increases, the relation being a linear one. If, therefore, for a given temperature t° we calculate the correction to be applied for the case $S' = 1$ and also for $S' = 10$ (or for any other pair of values of S' which it may be convenient to select) and plot these against the uncorrected specific gravity on a graph in which the ordinates give the values of S' and the abscissae the values of the correction, then the correction to be deducted for any intermediate value of S' can be found by reading off the value of the abscissa for the point where a line drawn through the given value of S' parallel to the abscissa axis cuts the straight line joining the two calculated points.

A series of such straight lines, each determined by two calculated points and corresponding to different temperatures between 6° and 30° C., can be drawn at intervals of a degree and give us the means of rapidly correcting an observed specific gravity determined at any temperature between these limits. A sheet of squared paper divided into inches and tenths and measuring 12 by 20 inches enables us to construct a convenient graph for specific gravities up to 7 and temperatures up to 20° C., and one which can be used for temperatures up to 25° C. when the specific gravity does not exceed 5. If a greater range is required a larger sheet of paper must be employed or the scale reduced by using a centimetre ruling. In the graph used in the author's laboratory a tenth of an inch on the abscissa axis corresponds to a value of 0·0001 in the correction, and the same interval corresponds to a change of 0·05 in the value of S' on the ordinate axis. The temperature curves are drawn at intervals of 1° C. This graph is illustrated in the plate (Pl. IV) which accompanies this paper. As reproduced, however, the scale is rather too small for convenience, but the original can be easily read and its range is sufficient for ordinary work.

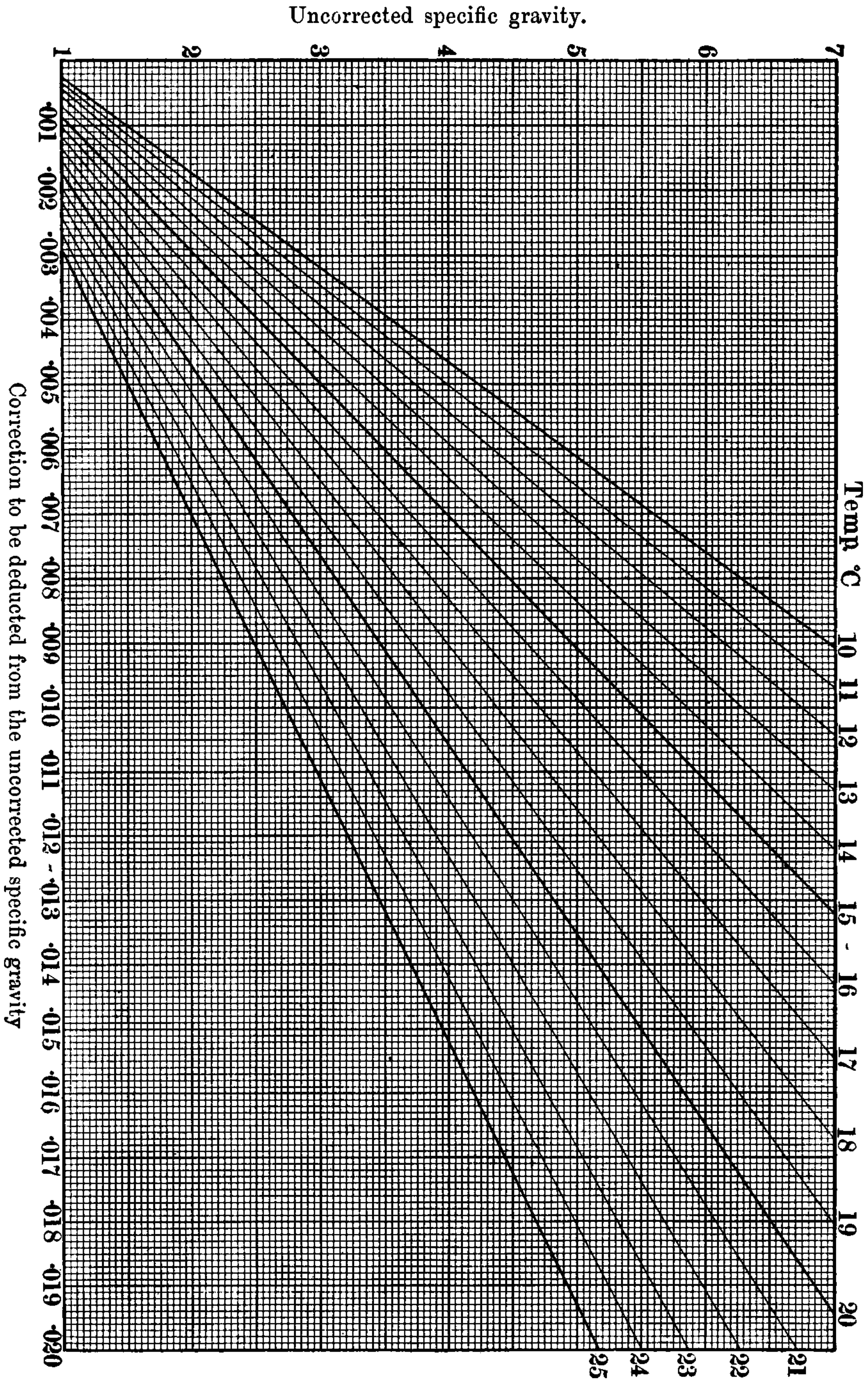
Graphs covering any desired range may be readily constructed by means of the following table, in which the calculated values of the correction are given for every degree from 6° to 30° C., and for the values of the uncorrected specific gravity 2, 5, 8, 11, 15, and 21. The inclined temperature lines all converge to a point on the line of zero specific gravity situated at 0·0012 (the weight of 1 c.c. of air) to the left of the point of origin.

Table of calculated Corrections for Specific Gravity.

Temp.	$S' = 2$.	$S' = 5$.	$S' = 8$.	$S' = 11$.	$S' = 15$.	$S' = 21$.
6° C.	0·00126	0·00495	0·00864	0·01233	0·01725	0·02463
7	0·00134	0·00514	0·00894	0·01275	0·01782	0·02543
8	0·00144	0·00539	0·00935	0·01331	0·01858	0·02650
9	0·00157	0·00572	0·00988	0·01403	0·01957	0·02788
10	0·00173	0·00612	0·01051	0·01490	0·02076	0·02954
11	0·00191	0·00658	0·01126	0·01593	0·02215	0·03150
12	0·00213	0·00711	0·01210	0·01709	0·02374	0·03372
13	0·00236	0·00771	0·01306	0·01840	0·02553	0·03622
14	0·00263	0·00836	0·01410	0·01984	0·02749	0·03897
15	0·00291	0·00908	0·01526	0·02143	0·02965	0·04200
16	0·00322	0·00986	0·01650	0·02313	0·03198	0·04525
17	0·00356	0·01069	0·01783	0·02497	0·03488	0·04876
18	0·00392	0·01159	0·01926	0·02694	0·03717	0·05252
19	0·00430	0·01254	0·02078	0·02903	0·04002	0·05651
20	0·00470	0·01354	0·02238	0·03123	0·04302	0·06071
21	0·00512	0·01459	0·02406	0·03354	0·04617	0·06512
22	0·00556	0·01569	0·02583	0·03597	0·04948	0·06976
23	0·00602	0·01685	0·02768	0·03851	0·05295	0·07461
24	0·00650	0·01805	0·02961	0·04116	0·05656	0·07967
25	0·00700	0·01931	0·03162	0·04392	0·06033	0·08494
26	0·00753	0·02061	0·03370	0·04679	0·06424	0·09042
27	0·00807	0·02196	0·03586	0·04976	0·06829	0·09609
28	0·00862	0·02336	0·03810	0·05283	0·07248	0·10195
29	0·00920	0·02479	0·04039	0·05599	0·07678	0·10798
30	0·00979	0·02627	0·04276	0·05924	0·08122	0·11419

Explanation of Plate IV.

The observed value of the specific gravity compared with water at temperature $t°$ is read on the left. A horizontal line is drawn to meet the diagonal temperature line $t°$. Vertically below this point of intersection is read the correction, which fraction is to be deducted from the observed value.



A. HUTCHINSON: SPECIFIC GRAVITY GRAPH.