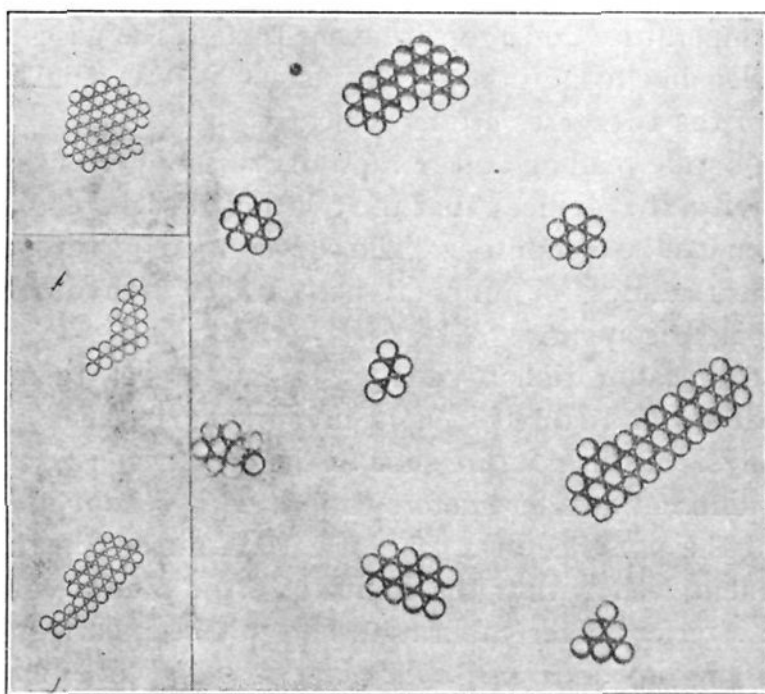


NOTES.

Soap Bubbles as Models of Crystal Structure.—When liquids which froth easily are filtered through a funnel in the ordinary manner, bubbles of equal size are sometimes formed at the top of the stem, and are carried down into the filtrate. On reaching the surface the bubbles form a symmetrical network, which is quite striking when seen for the first time.

The bubbles can be produced with much greater certainty by simply blowing air through a very fine orifice below the surface of a soap solution. The orifice is best prepared by drawing down a piece of glass tubing to about 1 mm. in diameter. A very fine tip is made at the end of this small tube by drawing it out in a smoky flame, and breaking it at the constriction so produced. It is well to bend the small tube in such a manner that when it is in position the tip will be nearly perpendicular to the sur-



face of the soap solution. It may be necessary to make several such tubes before a satisfactory one is obtained. For lecture purposes it is advisable to use a small gas holder for the air supply. This is not absolutely necessary, however, as the bubbles shown in the illustration were formed by merely blowing with the mouth through the tube. The size of the bub-

bles is determined largely by the dimensions of the orifice.

The solution can be prepared from Castile soap, although the bubbles last longer when sodium oleate is used. The addition of glycerine to the soap solution further increases the life of the bubbles.

An image of the bubbles can easily be thrown upon the screen by using a lantern arranged for the projection of objects lying in a horizontal plane. The combinations shown in the illustration usually form spontaneously, or they can be easily produced by moving the individual bubbles about by means of a fine glass rod.

It will be noticed in the illustration that any one bubble is surrounded by six other equidistant bubbles. If this arrangement could be completed in three dimensions, any one bubble would be surrounded by twelve other

equidistant bubbles. This arrangement is the simple face-centered lattice as found in crystals of the pure metals, where all the atoms present are identical. If we could form two classes of bubbles, in which bubbles of the same class attract each other to a lesser degree than bubbles of different classes, it would be possible to reproduce the structure shown by such substances as sodium chloride or potassium chloride, where any one atom is surrounded by six atoms of the other kind in three dimensions, or four atoms in two dimensions.

The only conditions necessary for a symmetrical arrangement are: first, the bubbles must be equal in size, and secondly, the attraction between any two of the soap bubbles must be a constant value, which is ensured by the surface tension of the soap solution. Similarly in the case of solids, where the kinds of atoms present are small in number, and where the intensities of the different attractions can consequently be divided into a small number of classes, the crystalline state is the only stable state.

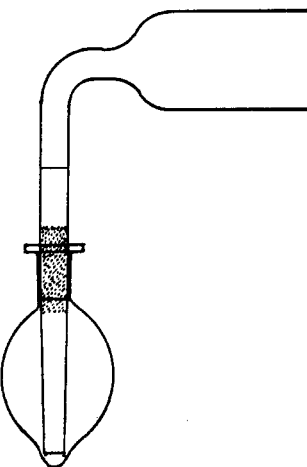
The models ordinarily used to demonstrate crystal structure show the final arrangement only, while the models here described are useful mainly in helping the student to understand the causes of the existence of crystal structure. The danger of introducing the idea of hard, incompressible atoms is also minimized, as the positions assumed by the bubbles are really equilibrium positions taken up under the influence of the air pressure in the bubble and the surface tension of the soap solution.

While these bubbles have been considered above only as models of crystalline solids, they can nevertheless also be used as models of liquid crystals, to which they bear an even more striking analogy.

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An Improved Form of Pycnometer.—Side-arm pycnometers have been variously modified to provide for the expansion of the liquid when densities are determined below room temperature. The side-arms of pycnometers, thus far seen by the author, do not extend far into the caps, when the latter are in adjustment. To care for the expansion of the liquid, either a small bulb is blown in one of the arms beyond the graduation mark, or the caps are provided with small holes at the ends. A much more satisfactory device than these, is that shown in the figure. The caps are made rather large and are constructed so that their interior ends just fail to touch the ends of



the side-arms. The expanded liquid touches the inside of the cap and flows down the greater incline of the latter rather than back along the arm. The side-arms are ground over a length a little greater than the sleeve of the cap.

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An Accurate Method for Taking Aliquots of a Standard in Standardizing Solutions.—Often in standardizing solutions, it is desirable to weigh out more of the pure material than is required for one titration and then use aliquots. This forces the analyst to resort to the use of graduated instruments, flasks, pipets, etc., which are not entirely satisfactory even when they have been standardized, because of temperature fluctuations and unavoidable errors of manipulation. The writer proposes the following method which eliminates these errors and appears to be entirely convenient and practicable. Method: about five times as much of the standard as is desired for each titration is weighed out carefully and dissolved in a quantity of water slightly exceeding five times the capacity of the pipet to be used in taking the aliquots. (The pipet need not be standardized, nor is it even necessary to know its exact capacity.) Five portions of the solution are now carefully drawn in an identical manner and the remainder together with the rinsings from the pipet, is transferred to a tared platinum dish, evaporated, dried and weighed. A simple calculation gives the exact weight of substance used for each titration. The method can only be used for such substances as Na_2CO_3 , $(\text{COONa})_2$, etc., which are soluble and separate from the solution again in a weighable form upon evaporation.

C. F. MILLER.

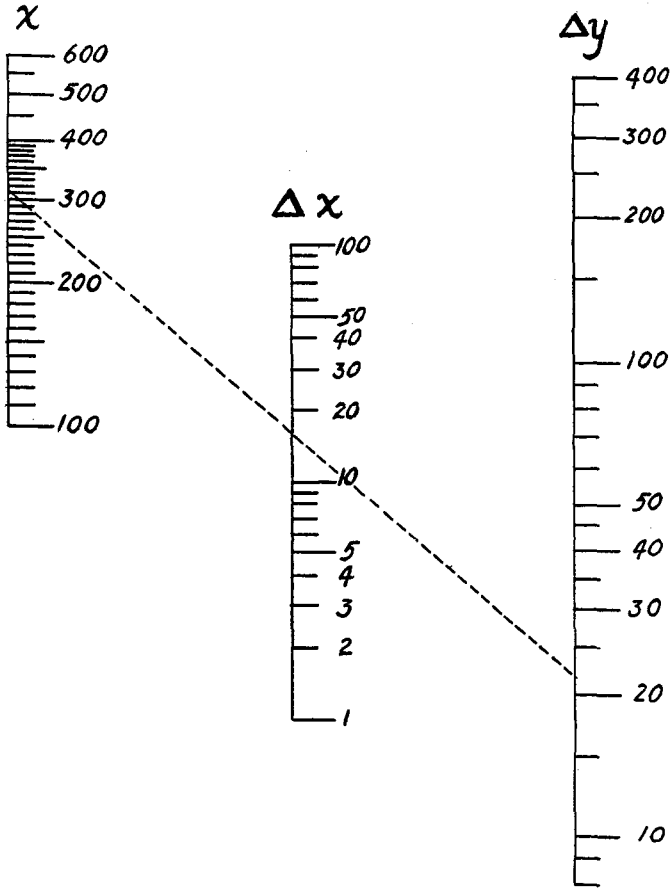
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The Graphical Interpolation of Tabulated Data.—Most of the time consumed in using tables giving the relationship between two variables is in working out interpolations between values given in the table, and most of the errors committed in the use of tables are doubtless those of interpolation. This note indicates a graphical method for finding the interpolation correction to be added to the values given in the table. It has the advantage over the mental calculation of interpolations in that it saves time and effort, and over the use of marginal tables of interpolation in that it permits most tables to be condensed to about ten per cent. of the space they would otherwise occupy. The principle of this device is that of a triple parallel alinement chart,¹ and as such will be self-explanatory to those familiar with graphical methods of calculation, its novelty con-

¹ d'Ocagne, "Traite de Nomographie," 144 (1899). For some chemical applications see Deming, *J. Ind. Eng. Chem.*, 8, 271, 451 (1916).

sisting in the application to interpolation, rather than in the principle involved.

The method of using the interpolation chart can be seen from the accompanying sketch, which is a diagrammatic representation of a chart prepared for use in connection with a five-place table of logarithms. Let it be required to find the logarithm of a number, say 3.1416, from a table giving the logarithms of three-figure numbers directly. In this case log



3.14 = 0.49693. To find the value to be added to this in interpolation connect 314, on the left-hand scale, with 16 on the middle scale, by means of a straight line ruled on the lower surface of a sheet of celluloid or other transparent material. Where this line intersects the right-hand scale will be read 22, which is the interpolation, in units of the fifth decimal place, to be added to the logarithm read from the table, giving the corrected logarithm 0.49715. The process of finding the number corresponding to a given logarithm is of course the converse of that indicated above.

Since values can be interpolated accurately and instantly by this device, it follows that they need not be tabulated at such frequent intervals as would otherwise be necessary. The interval between successive values of the argument of most tables is in fact less than that needed to insure the possibility of correct linear interpolation with first-order differences, in order that the labor of interpolations may be reduced as much as possible. When the interpolation is accomplished graphically, the reason for this sort of tabulation largely disappears, and it becomes possible to reduce the length of the tables enormously. Thus the five-place logarithmic table, whose interpolation chart is here illustrated, has been reduced in this way from twenty pages to two,¹ with almost no loss of accuracy. A seven-place table might be reduced in a similar way from about two hundred pages to twenty, an economy truly impressive.

In practice the three scales of the interpolation-chart would be set up in the right- and left-hand margins and in the middle of the page. Three separate zinc etchings may be prepared and set up with two columns of slugs from a linotype machine, for electrotyping. But the adjustment of the scales in such a case, in order to bring corresponding points into alinement, is apt to offer considerable difficulty, and it is much better to prepare an etching of the whole page as a unit.

The preceding statements are intended to make clear the nature, advantages, and method of use of interpolation charts in general. The method used in constructing such a chart for any table in two variables will now be briefly indicated. Let x be the independent variable or argument of the table, and y the function of that variable whose values are given by the table for successive round values of x . Let the increment of x beyond any value given in the table be Δx , and the corresponding increment of y , which is the interpolation correction to be added to the value of y given by the table, be Δy . If the value of Δy is to be given by a chart consisting of three parallel scales, it may be shown that a relationship must exist between the variables such that

$$f(x) + \phi(\Delta x) + \psi(\Delta y) = 0, \quad (1)$$

in which $f(x)$, $\phi(\Delta x)$, and $\psi(\Delta y)$ are any functions of x , Δx and Δy , respectively.

For example, in the construction of a table of logarithms we have

$$y = \log x; \text{ and } y + \Delta y = \log(x + \Delta x).$$

¹ This five-place table is printed in connection with the directions for the nomon (THIS JOURNAL, 39, 2137 (1917)). Tables of specific gravities and refractometric readings are being prepared for the next edition. In this connection a graphical method of double interpolation has been worked out that permits tabulated values of specific gravities and refractive indices to be corrected for variations from the standard temperature at the instant the interpolation is made. A collaborator is at work on a set of trigonometrical and engineering tables.

Taking the difference between these two equations, then transforming, we have

$$\log x - \log \Delta x + \log (10^{\Delta y} - 1) = 0;$$

which is evidently of the required form. In most cases it will not be possible to show that the condition given by (1) is satisfied, and this will be true especially when the relationship between the two variables whose corresponding values are given by the table is known but empirically, as is the case when tables of specific gravities or refractive indices are concerned. In such a case one needs to be content with a practical approximation.

If the values of the independent variables given by the table are at sufficiently small intervals, the interpolation correction Δy can be assumed proportional to the increment Δx of the independent variable. In other words, $\Delta y = F \cdot \Delta x$, in which F , the proportionality factor, is itself an undetermined function of x , which we may call $f(x)$. We have then

$$\log f(x) + \log \Delta x - \log \Delta y = 0, \quad (2)$$

which is evidently a special case of (1).

Having shown that the relation tabulated is of the form given by (1)—or, more commonly, having determined what is the maximum value of the interval between consecutive values of the independent variable that will still permit of linear interpolation of the values tabulated on a single page—we need only construct scales of the functions $f(x)$, $\phi(\Delta x)$ and $\psi(\Delta y)$. These scales are set up in the page any convenient distance apart, provided only that they be parallel, that the middle scale be exactly half way between the other two, and that corresponding points on the three scales be in alinement. In (2) the functions $\phi(\Delta x)$ and $\psi(\Delta y)$ are represented by $\log \Delta x$ and $\log \Delta y$, respectively; hence the scales for Δx and Δy are simple logarithmic scales that may be constructed with very little trouble, principal points being located with the aid of a table of logarithms and intermediate points by taking neighboring principal points, in groups of three, treating this range as if it were a projective scale. Having constructed two of the three scales in this way, the scale for x , which involves the undetermined function $f(x)$, may most easily be laid off by connecting points on the other two scales that correspond to selected values of x .

If any one of the quantities of Equation 1 is negative, this should be the variable selected for representation by the middle scale, otherwise the direction of increasing numerals of this scale will be from above downwards. Each unit of the function determining the distribution of points along the left-hand scale must be represented by the same distance as a unit of the distributing function of the right-hand scale, or twice the unit distance of the middle scale. The three scales will usually not be of equal length. Since the ratio of unit distances on the three scales is fixed, the

actual units in any case will be determined by the unit that needs to be adopted in the case of the longest scale, to bring that scale within the limits of the page.

Summary.

Tabulated data may be interpolated graphically by means of logarithmic scales printed in the margins and in the middle of each page of the table. The space occupied by most tables may thus be reduced very considerably.

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4,4'-DIMETHYL BENZOPHENONE AND ITS CONDENSATION WITH PHENOL.

BY M. GOMBERG AND J. D. TODD.

Received July 20, 1917.

4,4'-Dimethyl Benzophenone.—Carbon tetrachloride and benzene, under the influence of aluminum chloride, combine so as to give rise either wholly to triphenylchloromethane,¹ or to benzophenone chloride,² according as to whether benzene or carbon tetrachloride is in excess. The condensation of carbon tetrachloride with toluene is naturally more complex than with benzene, as various isomeric products can form simultaneously. None the less, with excess of toluene, fair yields (20 to 25%) of tri-*p*-tolyl chloromethane have been obtained,³ while with carbon tetrachloride largely in excess there results a mixture of isomeric tolophenone chlorides.⁴ On removing the aluminium chloride and evaporating the carbon tetrachloride, Boeseken obtained an almost colorless liquid which could not be distilled without partial decomposition. But on hydrolyzing the mixture of the various isomeric ketochlorides with acetic acid he succeeded in isolating pure 4,4'-dimethyl ketone.

We attempted to prepare 4,4'-dimethyl benzophenone chloride following the procedure of Gomberg and Jickling⁵ for benzophenone chloride, but found that the chloride suffered violent decomposition on distillation. Two mols toluene, mixed with an equal volume carbon tetrachloride, were allowed to drop into a suspension of aluminium chloride in about 300 cc. of carbon tetrachloride, the mixture being kept cold. After standing overnight, the aluminium chloride was decomposed with ice and, after drying over calcium chloride, the carbon tetrachloride was distilled off. On attempting to distil the ketochlorides in a vacuum, violent decomposition took place at about 175°, liberating large quantities of hydrochloric acid and forming a green resinous mass. The ketochlorides, without

¹ THIS JOURNAL, 22, 752 (1900).

² Boeseken, *Rev. trav. chim.*, 24, 1 (1905).

³ Gomberg and Voedisch, THIS JOURNAL, 23, 177 (1901).

⁴ Boeseken, *Loc. cit.*, p. 4.

⁵ THIS JOURNAL, 37, 2577 (1915).