Preparation of Graphs for *Science*

These suggestions are intended for the guidance of authors and draftsmen in preparing graphs for reproduction. They do not comprise a comprehensive set of suggestions but merely emphasize certain practices that often are disregarded. Although the discussion is confined to the simplest types of graph, many of the suggestions are applicable to line drawings in general. Most of the recommendations are in accord with those made in American Standards Association publication Z15.3.

Not more than three or four *curves* ordinarily should be shown on the same graph, although more may be included in the case of a family of well-separated curves. Use a solid line for an especially important curve and dashed, dotted, or lighter solid lines for the other curves. No curve or coordinate ruling of the graph should run through any lettering or outlined circles, triangles, and so forth, that are used to indicate plotted points.

Coordinate rulings should be limited in number to those needed to guide the eye in making a reading to the desired degree of approximation. Short scale markers, or "ticks," may be inserted between rulings if this is desirable. The rulings should be light enough not to distract attention from the curves being presented.

Lettering should be placed so as to be easily read from the bottom and from the right-hand side of the graph; that is, the lettering should face either the bottom or the right-hand side of the drawing.

A graph should be free of all lines and lettering that are not essential for clear understanding. As far as practicable, explanatory comments, supplementary data, or formulas should be placed in the figure legend or in the text. The exception to this rule is the case where there are several curves on the same graph that need separate identification; if practicable, they should be identified by brief labels placed close to the curve (horizontally or along the curve) rather than by single letters or numbers requiring a key.

If it seems necessary to place supplementary information on the drawing proper, the lettering should be kept within the vertical and horizontal limits of the curves or other essential features of the drawing. Otherwise the space occupied by the drawing may be needlessly large, or else the drawing may have to be reduced in reproduction, often to the point where the lettering or other details are illegible.

Scale captions should be placed outside the grid area, usually at the bottom toward the right for the horizontal scale and at the left-hand side toward the top for he vertical scale. The scale caption should consist of (i) the name of the variable plotted, (ii) its symbol, if one is used in the text, and (iii) in parentheses, the abbreviation for the unit of measure; thus, Pressure p (lb/in.^{2}). Avoid using such captions as "Pressure in lb/in.^{2}" and "Pressure in lb per sq in." The technical terms, symbols, and abbreviations on a drawing should be in accord with those used in the text of the article.

The *horizontal and vertical scales* for a graph should be chosen with care, so as to give a correct impression of the relationship plotted, for the choice of scales has a controlling influence on the apparent rate of change of the dependent variable. Except where a visual comparison of plotted magnitudes is important, the bottom (abscissa) and extreme left-hand (ordinate) coordinate lines need not represent the zero values of the variables plotted: this often results in a more effective graph as well as a saving of space.

The numerals representing the scale values should be placed outside the grid area. If the scale values are smaller than unity and are expressed in decimal form, a cipher should always precede the decimal point; thus, 0.20, not .20.

The use of many ciphers in scale numbers should be avoided, and the best way to do this is to reexpress the quantity plotted in terms of a larger unit of measurement. For example, suppose that originally the scale numbers are 15 000, 20 000, 25 000 . . . and that the scale caption is "Pressure (lb/in.^{2})"; these scale numbers can be changed to 15, 20, 25, . . . , provided that the unit is changed to 10^3 lb/in.^{2} If, in this example, the data are correct to three significant figures and it is desirable to indicate this fact, then the scale figures should be 1.50, 2.00, 2.50, . . . , and the unit, 10^4 lb/in.^{2} *Never* use captions of the types: "Velocity $\times 10^3$ in ft/sec" and "Velocity (ft/sec $\times 10^3$)." They are ambiguous, since they do not indicate clearly whether the scale numbers *have been* or *are to be* multiplied by 10^3.

A brief *legend* should be provided for each graph. All legends are set in type and hence should be typewritten double-spaced, in a list on a separate page.

Black drawing ink should be used. Many writing inks do not reproduce well. Drawings should be made on tracing cloth, tracing paper, or a fairly heavy white paper having a dull surface that will stand erasure without roughening. Ruled coordinate paper may be used, provided that it is printed in light blue; the important coordinate lines and scale markers that are intended to appear in the reproduction must be ruled in ink.

A good *size for a drawing* is double that desired for the printed figure; *all lettering and line thicknesses should be increased accordingly.* Thus, a drawing that is to be reproduced column-width in *Science* should be made not more than 6 in. wide over-all. A simple drawing containing little detail may often be so planned that the printed figure can be made less than column-width.—D. R.