Comments and Communications

Allotment of Funds for Research

In the current discussion as to regional *vs.* national distribution of research funds (Clarence A. Mills. *Science,* February 6, pp. 127–130; October 22, p. 438; and Thomas B. Turner. *Science,* April 16, p. 391) there seems to be some confusion as to the purpose of such funds. If funds are raised to aid in the solution of some scientific problem (as *research* implies), then I see no relevance of this to regional distribution. If it happens that the Northeast is now better equipped to produce desired results, that is where the money should go. If some one problem can best be handled elsewhere, then it should be handled there. Research results (the aim in view) are valid, regardless of where or by whom produced.

If, on the other hand, the purpose is an over-all national development, as Dr. Mills implies, then the funds are given the wrong name. They are not *research* funds unless they are to be used for research.

Probably we need two funds, one for each of these worthy objectives, but these objectives should not be confused as they apparently now have become. As an impartial observer from a region not well represented in the present allotment of these funds, I cannot see that Dr. Mills has proved his implication that most funds have gone to the East because eastern scientists on the allotting boards are biased for their own institutions and regions.

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A Simple Method of High-Power Tissue Stimulation

For those physiologists faced with the necessity of stimulating nerves or other highly sensitive tissues, Dr. Schmitt's ingenious R.F. circuit outlined in an earlier issue of *Science* (April 23, p. 432) is doubtless a most satisfactory solution. Unfortunately, those who require relatively high-power stimulation are unable to use his device because of the inherent power limitations of the circuit and the associated restriction to relatively high-impedance leads.

A method for high-power stimulation is described here which permits ordinary stimulators to be operated with enough conductive and capacitive isolation from ground to enable relative freedom of sensitive recorders from shock artifact. This method is very simple and does not require the construction of any special electronic circuits.

A high-powered stimulator, of the type usually operated off house current (110 v a-c), is plugged into a 12-v d-c–115-v a-c inverter instead of the normal wall outlet. This inverter is in turn connected to two automobile-type storage batteries arranged in series. The stimulator, inverter, and storage batteries are placed close together on a nonmetallic surface at least several feet from the nearest sizable metal object. Fig. 1 indicates the connections made between these and the charger required for the batteries. Two charger switches are necesary to insure satisfactory electrical isolation of the apparatus.

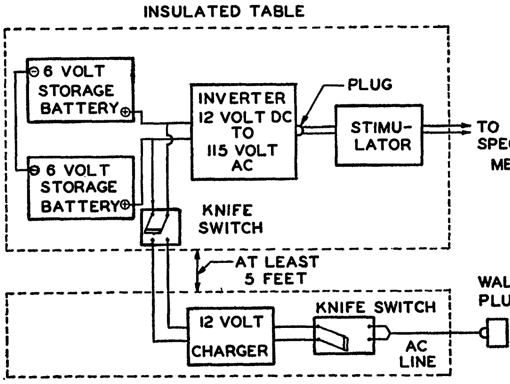

FIG. 1

When the stimulator is to be operated, the charger switches are opened.

It has been found necessary to ground the specimen at one point in order to eliminate a-c interference from the records.

The stimulator, inverter, batteries, and charger are all available commercially.

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Cenogonal—A New Crystallographic Term

In a consideration of the various types of zones (A. F. Rogers. *Introduction to the study of minerals,* 3rd ed., 1937, pp. 33–35) encountered in geometrical crystallography, I have felt the need of a word to designate angles that are common to two or more crystal species.[1] The angles to which I refer are angles such as 26°34′ (arc cot 2),[2] 18°26′ (arc cot 3), 14°2′ (arc cot 4), and in general arc cot n, where n is rational; also such angles as 16°6½′ (arc cot $2\sqrt{3}$), 10°53½′·(arc cot $3\sqrt{3}$), and in general arc cot $n\sqrt{3}$, where n is rational.

At first I considered expanding the term "crystallometric," used by Nevil Story-Maskelyne (*Chem. News,* 1875, 31, 101) and elaborated upon in his textbook (*Crystallography, a treatise on the morphology of crystals,* 1895, p. 77). By crystallometric angles, Story-Maskelyne meant the angles that planes of symmetry make with each other, which are 30°, 45°, 60°, and 90°. W. J. Lewis (*A treatise on crystallography,* 1899, p. 21) also used crystallometric in the same sense, but it is a very rare word in crystallographic literature.

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[1] "Crystal species" is used to include crystals produced in the laboratory as well as mineral crystals.

[2] The expression arc cot is preferred to the symbol $\cot^{-1}$.

Generally speaking, redefinition of terms is unwise in my opinion. I have therefore cast about for a suitable word. The Greek κοινός (common) comes to mind, since its primary meaning is ''shared in common.'' The angles mentioned above are common to various crystal species.

My colleague, Raymond Harriman, of the Classics Department, called my attention to the fact that in using the expression ''cenogonal angle'' one is repeating the idea of angle, since γωνία is the Greek word for angle, but in spite of this, the term seems the best one available.

Cenogonal angles include the angles in the tetragonal zone [001] of the tetragonal system as well as the angles in the hexagonal zone [00–1][3] of the hexagonal system and all the angles between the faces of crystals in any of the zones of the isometric system. In Dana's *System of mineralogy* (6th ed., 1892) a fairly complete list of these angles may be found (pp. xx–xxvi). It should be emphasized that cenogonal angles are predictable; that is, they may be calculated in advance of any knowledge of the axial ratio. The use of a special term such as ''cenogonal'' emphasizes the importance of the predictable angles.

I wish to acknowledge my indebtedness to my colleagues, Harry Caplin, J. D. H. Donnay, H. F. Fränkel, S. A. Francis, R. D. Harriman, Philip Harsh, Stanley Herold, R. F. Jones, Louis H. Kanter, Lionel Pearson, K. C. Peer, G. Polya, and Julian Smith, for the opportunity of discussing various terms.

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Criticism of a Definition of pH

The following definition has appeared in a long series of editions of the Chemical Rubber Publishing Company's *Handbook of chemistry and physics*: ''Hydrogen ion concentration or pH value is the logarithm of the reciprocal of the gram ionic hydrogen equivalents per liter; i.e., $\mathrm{pH} = \log \frac{1}{(\mathrm{H}^+)}$ per liter.'' Thus, it would appear that pH is the negative logarithm of pH, like the man in the popular song who was his own grandfather. Several times I have called the attention of the editor of the Handbook to this error, but so far without result.

The relation, $\mathrm{pH} = -\log (\mathrm{H}^+)$, in which (H^+) is the hydrogen ion concentration, as given by Sorensen in 1909, represented the prevailing ideas sufficiently well at that time. Since then the meaning and the calibration of the pH scale have received both theoretical and experimental attention with the result that quite a number of papers have accumulated on the subject (Cohn, Heyroth, and Menkin. *J. Amer. chem. Soc.*, 1928, 50, 696; Guggenheim and Schlinder. *J. phys. Chem.*, 1934, 38, 533; Hitchcock and Taylor. *J. Amer. chem. Soc.*, 1937, 59, 1812; MacInnes, Belcher, and Shedlovsky. *J. Amer. chem. Soc.*, 1938, 60, 1094; R. G. Bates. *Chem. Rev.*, 1948, 42, 1; etc.). In possibly all but one case in a thousand it is not necessary to consider the meaning of pH in terms of solution theory at all, but only to accept the numbers as a practical scale of acidity and alkalinity.

From an operational point of view, pH values are the result of measurements of the potentials, E, of galvanic cells of the type: $(\mathrm{Pt})\mathrm{H}_2$; solution X : sat'd KCl; reference electrode with the aid of the equation,

$$\mathrm{pH} = \frac{\mathrm{E} - \mathrm{E}_0}{2.306\,\mathrm{RT/F}}.$$

Here ''solution X'' is the fluid whose pH is desired, E_0 is a constant depending upon the nature of the reference electrode and the temperature, and R, T, and F are the gas constant, the absolute temperature, and the faraday, respectively. For most purposes, therefore, it is only necessary to agree on values of the constant E_0. However, studies have been made leading to closely agreeing values of this constant at a series of temperatures such that, if the pH measurements are interpreted in terms of thermodynamic ionization constants, no serious errors will be made.

According to present theories of electrolytes, there is no simple relation between the hydrogen ion concentration and the pH value of a solution. The relation $\mathrm{pH} = -\log (\mathrm{H}^+)$ is an approximation only, and using it as a definition may lead to serious errors. The expression $\mathrm{pH} = -\log a_{\mathrm{H}^+}$, in which a_{H^+} is the activity of the hydrogen ion, is also open to objection, since the activity of a single ion species is not an operational concept.

It is the author's rather forlorn hope that compilers of handbooks and authors of textbooks will someday indicate that the expression $\mathrm{pH} = -\log (\mathrm{H}^+)$ is *not* a definition and that it may be, in some cases, only a very rough approximation.

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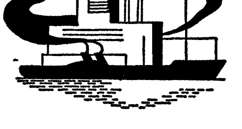

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[3] In zones of the hexagonal system the writer prefers the method of omitting the third index.