[1] The data were collected by both authors at the College of Agriculture, University of Illinois. The senior author is alone responsible for the manuscript and any views or shortcomings it may contain.

[2] Detlefsen, A., These PROCEEDINGS, 6, 1920 (663–670).

[3] Weinstein, A., *Genetics*, 3, 1918 (135–174).

[4] Sturtevant, A. H., These PROCEEDINGS, 7, 1921 (181–183).

[5] Sturtevant, A. H., *Carnegie Institution, Washington, Publ.*, No. 278, 1919 (305–341).

[6] *Loc. cit.*

[7] Sturtevant, A. H., *Carnegie Institution, Washington, Publ.*, No. 301, 1921 (1–150).

[8] Punnett, R. C., New York, 1919, 192 pp.

[9] Walter, H. E., New York, 1922, 354 pp.

[10] Babcock, E. B., and Clausen, R. E., New York, 1919, 675 pp.

[11] Nachtsheim, H., *Zs. Ind. Abst., Vererb.*, 20, 1919 (118–156).

[12] Sharp, L. W., New York, 1921, 452 pp.

[13] We are indebted to Drs. Bridges, Morgan and Muller and Sturtevant, who generously furnished the foundation stocks necessary to build up these special test strains.

[14] Gowen, J. W., *Genetics*, 4, 1919 (205–250).

THE DISPLACEMENTS OF THE CAPILLARY ELECTROMETER, FOR PROGRESSIVE DILUTIONS OF THE ELECTROLYTE

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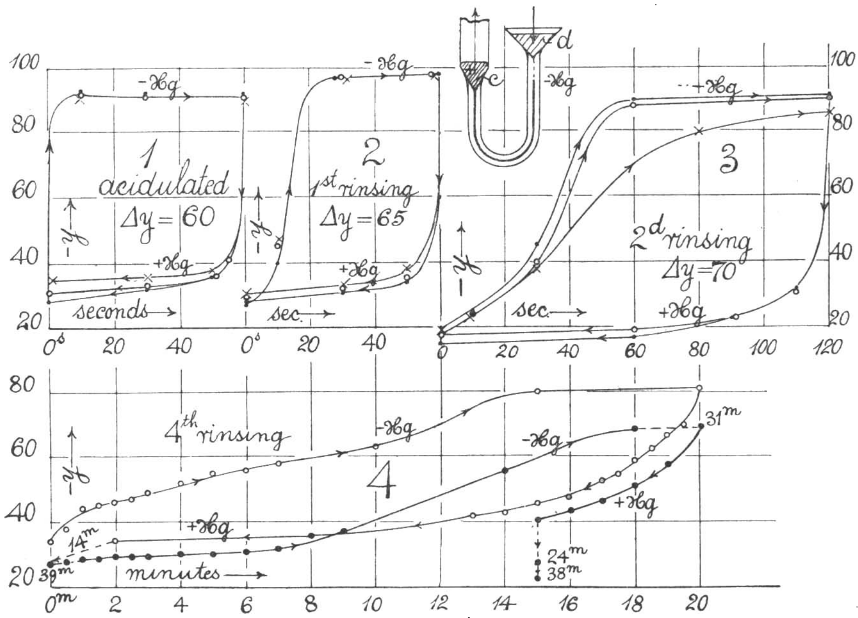
Communicated, March 23, 1923

1. The attached graphs, obtained incidentally, seem to be of sufficient interest to be recorded. The capillary electrometer is shown in diagram in the inset, the mercury thread being about 1 mm. in diameter. The meniscus below d is in contact with the electrolyte, while a platinum wire dips into the broad meniscus at c, so that but one meniscus is in question. The displacements were observed with a microscope provided with an ocular scale, of which 1 scalepart y corresponded to .041 mm. of depression, at the meniscus. They are recorded as observed with an *inversion*, so that a rise of meniscus corresponding to a + charge happens to be laid off downward and a depression of meniscus (negative charge) upward. The ordinates therefore are $-y$. One ($ZnSO_4$) Daniell cell and a commutator were used for charging, the electrodes being alternately earthed.

2. In the graphs, figure 1, the electrolyte (inset d) was distilled water, to which a drop of dilute sulphuric acid had previously been added and mixed. The observations were made in seconds, after closing and after opening, the cycles given (points distinguished) are the 4th, 5th, and 6th. The equivalent of the Daniell cell is here about $\Delta y = 60$ scaleparts.

3. The whole of the electrolyte in d was now removed and replaced by distilled water, the mercury thread being left in place. The three new cycles, figure 2, show a somewhat enhanced displacement, Δy; but the feature of the results is the much more rapid displacement of the negative meniscus, as compared with the positive meniscus. Graphs in the latter case are always doubly inflected; not so in the former.

4. The electrolyte was now again removed and replaced by distilled water. The cycles obtained after this second rinsing are shown in figure 3. There has been further and now very marked retardation of the whole



phenomenon; nevertheless the discharge of the negative surface is still strikingly rapid as compared with the discharge of the positive surface. The total displacement Δy is possibly larger than before.

5. Correspondingly progressive results were obtained in the 3rd rinsing. I shall therefore only give the record for the 4th rinsing, in figure 4. The phenomenon has now been so far retarded, that a time scale of *minutes* is necessary. Even this does not suffice, so that the long intervals are indicated by broken lines. The supply of ions (presumably proportional to the fall of potential per second) is now very meager; still the mercury surface parts with its positive ions appreciably more reluctantly than with its negative ions, and the latter graphs, as heretofore, are not doubly

inflected. All this fits in very well with the theory of Helmholtz and Lippmann based on the 2nd law of thermodynamics. One may regard the kinetic pressure of the negative ions within the metal as continually in excess of the pressure of the positive ions; so that in like fields of the double layer, the former escape sooner.

THE TRANSFER IN QUANTA OF RADIATION MOMENTUM TO MATTER

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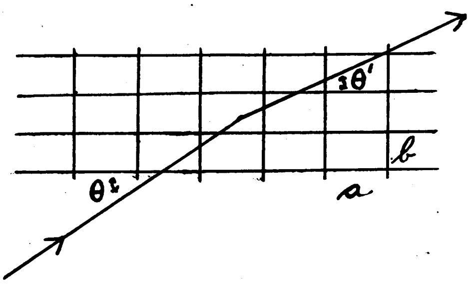
Communicated, March 2, 1923

1. The reflection by a crystal of X-radiation characteristic of the atoms in the crystal itself, which Dr. G. L. Clark and the writer discovered (these Proceedings, May, 1922 and April, 1923), does not appear to be explainable in a simple manner by the theory of interference of waves. This note describes an attempt to formulate a theory of the reflection of X-rays by crystals, based on quantum ideas without reference to interference laws.

2. The fundamental hypothesis of the theory now presented is that the *momentum* of radiation is transferred to and from matter in quanta, and further, that the laws of the conservation of energy and of momentum apply to these transfers.

3. In order to illustrate the meaning of this hypothesis, let us take a particular example, namely, that of the reflection of an X-ray by a crystal. For the sake of simplicity, let us assume that the axes of the crystal lie



at right angles to each other and take the particular case in which the X-ray strikes the crystal in a direction parallel to one set of principal planes. The problem thus becomes a two-dimensionable one. Suppose