

# The Origins of Positive and Negative in Electricity

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## Question

What is the origin of the positive and negative notation in electricity ?

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## Answer

The terms positive and negative were first introduced into electrical theory by Benjamin Franklin (figure 1) in 1747 (1). Franklin is considered to be the originator of the single-fluid theory of electricity, in contrast to the two-fluid (i.e., vitreous and resinous) theory proposed earlier by the Frenchman, Charles Dufay (2). According to Franklin, electrically neutral matter contained a certain equilibrium amount of electrical fluid. However, rubbing an object disturbed that equilibrium and caused certain objects to acquire an excess of electrical fluid and others to acquire a defect of fluid. The terms positive and negative originally had nothing to do with so-called inherent electrical charge, but rather indicated which object had an excess of electrical fluid (positive) and which had a deficiency (negative).

The electrical fluid was attracted to matter but was self-repulsive. Consequently positive-negative interactions were attractive, leading to a flow of fluid from the positive to the negative object and the reestablishment of electrical equilibrium, whereas positive-positive interactions were repulsive. Franklin did not recognize the existence of negative-negative repulsions, and it remained for the German-Russian physicist, Franz Aepinus (1724-1802), to point out that their existence required the additional hypothesis that matter-matter interactions were also inherently repulsive (3). Since this assumption was at odds with the traditional assumption, based on both the theory of gravitation and chemical affinity, that matter-matter interactions were



Figure 1. Benjamin Franklin (1706-1790).

inherently attractive, the two-fluid theory remained dominant throughout most of the 19th century.

The most obvious interpretation of the Franklin-Aepinus theory in modern terms is that the electrical fluid corresponds to the electron cloud of an atom and the underlying matter to the atomic nucleus. Unfortunately modern theory also reveals that Franklin's assignments of positive and negative accumulations of electrical fluid are exactly the reverse of those corresponding to an excess or deficiency of electrons, thus necessitating the assignment of a negative sign to electron excesses and a positive sign to electron deficiencies. The result is our current convention of using inherent charge signs and the continued practice of defining current direction as positive charge flow, though in

fact it is the negative electrons that are really flowing in the opposite direction.

Franklin's original assignment of positive and negative was an accident of the fact that he began his electrical experiments as a result of having received a glass "electric tube" as a gift from the Englishman, Peter Collinson, and his assumption that rubbing caused it to accumulate excess electrical fluid (in fact the glass loses electrons to the silk). Had he instead received an amber or resin rod and made the same assumption (amber gains electrons when rubbed with flannel), our current conventions would correspond to Franklin's original intentions (4).

It should be noted that Franklin did make some attempts to verify his initial assumption and in his early letters to Collinson describes his efforts to determine the "afflux and efflux" of the electrical fluid between objects by means of (5):

*... little, light windmill-wheels made of stiff paper vanes, fixed obliquely, and turning freely on fine wire axes; also by little wheels of the same matter, but formed like water-wheels.*

Later he thought he could deduce the direction of fluid flow by observing the nature of the electrical discharges around objects (6):

*When the brush is long, large, and much diverging, the body to which it joins seems to me to be throwing the fire out; and when the contrary appears, it seems to be drinking in.*

Needless to say, both methods were defective and he never detected the fallacy of his initial assumption

### Literature Cited

1. B. Franklin, *Letters and Papers on Electricity*, in J. Sparks, Ed., *The Works of Benjamin Franklin*, Vol. V, Childs & Peterson: Philadelphia, PA, 1840.
2. D. Roller, D. H. D. Roller, *The Development of the Concept of Electrical Charge*, Harvard Case Histories in Experimental Science, No. 8, Harvard: Cambridge, 1964.
3. F. U. T. Aepinus, *Essay on the Theory of Electricity and Magnetism*, Princeton University Press: Princeton, NJ., 1979. English translation of the original Russian edition of 1759.
4. J. Pilley, *Electricity*, Clarendon: Oxford, 1933, p. 33.
5. Letter to Peter Collinson of 11 July 1747, Ref. 1, p. 184. An attached note indicates that by 1750 Franklin was aware that the rotation of the paper vanes was due to electrical repulsions and not to the flow of the electrical fluid.
6. Letter to E. Kinnersley of 17 March 1752, Ref. 1, p. 282.

*Do you have a question about the historical origins of a symbol, name, concept or experimental procedure used in your teaching? Address them to Dr. William B. Jensen, Oesper Collections in the History of Chemistry, Department of Chemistry, University of Cincinnati, Cincinnati, OH 45221-0172 or e-mail them to [jensenwb@ucmail.uc.edu](mailto:jensenwb@ucmail.uc.edu)*