

for it in the ultra-violet absorption spectra since, for the short time ($\approx 10^{-15}$ sec.) required for ultra-violet absorption, the bonds are effectively localized and only delocalized when considered over times $> 10^{-14}$ sec.

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Density of Water adsorbed on Wyoming Bentonite

At the present time, two schools of thought exist concerning the density of water adsorbed on clays. Hendricks and Jefferson¹ and Macey² postulated structures for this adsorbed water which are less dense than free water; whereas, Williamson^{3,4} and Mackenzie⁵ have argued against these postulates and have suggested that the adsorbed water is denser than free water. Barshad⁶ has proposed that the adsorbed water is closely packed at high states of hydration.

Attempts to measure the adsorbed-water density have been based on the pycnometer and X-ray methods. These methods have given contradictory results, probably because of the assumptions involved.

We compressed a clay-water paste between a porous filter and a column of mercury and observed, simultaneously, by means of capillaries, the change in volume of the clay paste and the volume of water forced through the filter. From these observations we were able to plot the volume of the clay paste against the weight of water in the paste. The slope of the line at any water content is the reciprocal of the water density at that water content.

By this method we obtained the densities of water adsorbed on homoionic Wyoming bentonites saturated with either lithium, sodium or potassium ions. We found that for each clay the water density decreased continuously with decreasing water content. At 25° C., and a water content of 0.6 gm. of water per gm. of clay (7.5 A. from the clay surface if the surface area is 8×10^6 sq. cm. per gm. of clay), the densities of the water on lithium, sodium and potassium clays were 0.975, 0.972 and 0.981, respectively. Thus, the adsorbed water is less dense than free water.

A detailed account of this research will be published in the *Proceedings of the Soil Science Society of America*.

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Secular Changes of the Units and Constants of Physics

GERHARZ¹ has recently proposed a new method for determining the velocity of light in terms of a standard frequency and of the wave-length of an atomic radiation. He expects to reduce his experimental errors to less than 1 part in 10^8 and suggests that it should then be possible to obtain evidence about secular changes in the velocity of light. Dingle², on the other hand, follows Clemence in arguing that if the unit of time is defined in terms of the frequency of some atomic transition and that of length in terms of the wave-length of an atomic radiation, then the velocity of light is implicitly constant, no evidence can be obtained of its changes relative to atomic constants, and the science of physics is restricted at its foundations. The conflict between these two statements shows that the meaning of such phrases as 'secular changes in the velocity of light' needs clarification.

The measurable quantities of physics are defined in terms of a few of their own class; these latter cannot be defined verbally in terms of any other entities, but can only be indicated, that is, defined ostensively. Thus, taking length, mass and time as basic mechanical quantities, we can only indicate "that is length", but we can give velocity the verbal definition, "length per unit time". Since we can only define the basic quantities ostensively, we have to maintain material representations of them on which to found a system of units of these basic quantities, but once such a system is available, units of other quantities can be derived from their verbal definitions.

All physical measurements depend on comparisons of like quantities (in 'absolute' measurements the quantities compared are arranged to be fundamental quantities) and the comparisons are necessarily of the quantities at the same instant of time. If one wishes to compare A at time t_a with B at time t_b it is necessary to assume that one or other of them has not changed between t_a and t_b , and if one wishes to compare A at time t_1 with A at time t_2 , it is necessary to assume that some other quantity that may be compared with A has not changed in the interval. In dealing with the material representations of the fundamental units, this assumption can be neither proved nor disproved by arguments based on other measurements, but can only be justified by arguments drawn from our general beliefs about the nature of physics. Thus, in deciding whether to derive the unit of time from the period of rotation of the Earth about its axis or that of its revolution about the Sun, the most that measurement can do is to tell us how the ratios of these periods to each other and to other observable periods have changed: the decision must be based on such theoretical considerations as the possible perturbations that may affect the motions or, bearing in mind the changes of the ratios of each to other periods, that it is more probable that one has changed than the other. A like situation arises in comparing the period of a certain transition of the caesium atom with celestial periods.

It is clear, then, that with the fundamental quantities we cannot go beyond the material representations and that it is meaningless to speak of changes in the units. Such questions as whether the unit of length has changed are without meaning within the field of experimental physics.