sidered, or to those which are expansions and continuations of them, for the student is thus confirmed in his bad habit of being satisfied with a statement from a text-book, rather than encouraged to seek the real source, the journal article. Another disadvantage arising from this lack of references is the very real danger that the reader will feel that at any point the last word had been said on the subject, whereas a glance at the original papers would show him in truth that it was only the first.

Since an international committee has already established a notation for use in Physical Chemistry, it would seem a pity that the authors in this text have adhered to a local one, for it will needlessly confuse the reader.

The fact that this is the final revision of the preliminary editions of 1917 and 1920 is assurance that few if any misprints or errors are likely to be found in the text.

A list of the chapter headings given below will show the general scope of the book:

Part I *The atomic, molecular and ionic theories and properties of substances directly relating to these theories.*
The composition of substances and atomic theory. The molal properties of gases and the molecular and kinetic theories. The molal properties of solutions and the molecular theory. The atomic properties of solid substances. The electrolytic behavior of solutions and the ionic theory.

Part II *The rate and equilibrium of chemical changes from mass-action and the phase view points. The rate of chemical changes.*
The equilibrium of chemical changes at constant temperature. Equilibrium of chemical systems in relation to the phases present.

Part III *The energy effects attending chemical changes, and the equilibrium of chemical changes in relation to these effects.*
The production of heat by chemical changes. The production of work by isothermal chemical changes in relation to their equilibrium conditions. The production of work from isothermal changes by electrochemical processes. The effect of temperature on work producible by isothermal chemical changes and on their equilibrium conditions. Systematization of free-energy values.

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SPECIAL ARTICLES

SAND DROWN, A CHLOROSIS OF TOBACCO AND OTHER PLANTS RESULTING FROM MAGNESIUM DEFICIENCY

IN connection with recent field investigations in the improvement of tobacco production conducted by the Bureau of Plant Industry in cooperation with the North Carolina Department of Agriculture attention was directed to a characteristic chlorosis of the leaves of tobacco plants on certain test plots. Investigation disclosed the fact that this disease often causes serious damage to the tobacco crop on certain types of soil, particularly in comparatively wet seasons. The popular name of this chlorosis is "Sand Drown," a term referring to the fact that the disease is likely to occur in aggravated form on the more sandy portions of the field after heavy rainfall. As a result of considerable field and laboratory study extending through several seasons this malady has been found to be due to an insufficient supply of magnesium in the soil or fertilizer. It has been found, further, that the ratio between the quantities of sulfur (sulfate) and magnesium contained in the fertilizer is a factor of importance, the symptoms of magnesium deficiency being intensified by increase in the quantity of sulfur applied to the soil. The details of the investigations will eventually appear in the *Journal of Agricultural Research* but because of considerable delay in publication resulting from temporary suspension of this journal it seems desirable to present at this time a brief outline of the principal facts established. The chlorosis in question usually begins at the tip and along the outer margins of the older leaves, advancing toward the leaf base and extending progressively to the upper leaves of the plant. In some cases, however, the chlorosis involves large portions of the leaf surface when first clearly recognizable. The veins and midrib of the leaf tend to retain their normal color. There is more or less complete blanching of the leaf lamina, both yellow and green chlorophyll pigments being affected

(thus differing from the chlorosis caused by potassium deficiency in which the affected area acquires a dull yellow color with a bronze or copper overcast). The blanched tissues usually do not die as quickly as in potassium deficiency so that local specking or spotting of the leaf is commonly wanting except in advanced stages of the malady. In some instances, however, local dying of the tissues between the veins has been the first symptom. In plot tests conducted in several tobacco-growing districts, in which chemically pure sources of nitrogen, phosphorus, potassium, calcium and sulfur were used instead of the ordinary commercial fertilizer materials, the symptoms of magnesium deficiency have usually appeared where sandy and sandy loam soils were used and there was abundant rainfall. In all such cases addition of sulfate or chloride of magnesium to the fertilizer salts has prevented the chlorosis. In comparative tests, applications of the so-called high grade or relatively pure commercial forms of the sulfate and chloride of potassium have resulted in severe chlorosis while low grade sulfates and chlorides of potassium containing considerable quantities of magnesium, such as "double manure salt" and "kainit," have prevented the disease. In some cases use of the purer forms of sulfate of potassium has resulted in severer chlorosis than that caused by the chloride and, moreover, the severity of the chlorosis has been proportional to the quantity of sulfate of potassium used. Symptoms of the disease also have been prevented by applying dolomitic limestone to the soil while comparatively pure calcite has been ineffective. Certain organic fertilizer materials of vegetable origin which are commonly used as sources of nitrogen, notably cotton seed meal, tobacco stalks and stems and barn manure, tend to prevent the disease. These materials contain appreciable quantities of magnesium. Use of other common sources of fertilizer nitrogen which contain little or no magnesium, including nitrate of soda, dried blood and especially ammonium sulfate, has favored development of the disease. In pot cultures this chlorosis is readily induced by applying a nutrient solution containing all the usual plant food elements except magnesium, using an excess of the solution so as to produce a leaching action on the soil. Moreover, the disease if not too far advanced is readily cured by adding magnesium to the nutrient solution. In view of the relation of the sulfur supply to the symptoms of magnesium deficiency it is worthy of note that an inadequate supply of sulfur *per se* results in a mild, diffuse type of chlorosis of tobacco, affecting all green parts of the plant and thus differing from the symptoms of magnesium deficiency. Since more or less sulfur is constantly added to the soil through rainfall, while there is loss of magnesium through the leaching action of the rain water, it is to be expected that symptoms of magnesium deficiency will be especially pronounced in wet seasons. In dry seasons the likelihood of relative deficiency of sulfur is increased. Experiments with corn, a crop plant differing widely from tobacco in many respects, show that it also is subject to the "sand drown" disease, the symptoms and characteristics of the disease in corn corresponding rather closely with those found in tobacco. It seems likely, therefore, that other crop plants are subject to injury from an inadequate supply of magnesium in the lighter, more sandy type of soils. Apparently the quantity of magnesium required in the fertilizer to prevent the symptoms of magnesium deficiency is small, probably less than 50 pounds per acre. These investigations suggest that the element magnesium needs to be taken into account both in the general problem of liming and in the proper choice of commercial fertilizer materials for making up so-called complete fertilizers.

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TRANSFERENCE OF THE BEAN MOSAIC VIRUS BY MACROSIPHUM SOLANIFOLII

IT has been assumed by pathologists that the virus of bean mosaic is transferred from diseased to healthy plants by insects. No experimental proof has been submitted to substantiate this claim. The only satisfactory ex-