It is true that with the establishment of a mining course in Johannesburg the engineering establishment at the South African College is faced to a certain extent by competition, but there is no reason why the earlier stages of instruction should not be taken at the South African College and the final stages at Johannesburg, where special facilities will exist. As to the future contingency of overlapping, Prof. Hele-Shaw suggests, in the probable event of an engineering faculty being established, that while the Transvaal could devote itself solely to mining engineering, the Cape University could develop the study of naval, architectural and marine engineering, for which there would be special facilities in the peninsula.

In his remarks on the future relations of the University of the Cape of Good Hope and the Transvaal Institute, Prof. Hele-Shaw said the present year will see the work of a professorship of engineering commence at both places, and continued, "There need be no fear of overlapping, since such a course, though suitable, and, indeed, necessary, for any branch of the constructive professions, can in the later stages be specialised to suit the local requirements. Thus in the north mining would naturally be a strong feature of a special course, whilst your city (Cape Town) has possibilities in the way of naval architecture and marine engineering which even the wildest dreams of the projector of the ship canal to Johannesburg would never contemplate for the latter city. Such a faculty of engineering, if true to its proper aims, would, by right, take its place, as representing a learned profession amongst the other great faculties, and would doubtless have its distinctive university degrees."

Speaking more particularly of the new institution at Johannesburg, Prof. Hele-Shaw said :—"The university idea will, I trust, even at its initial stages, be fully maintained in the Transvaal Institute, not by any mere artificial standards of entrance, but by the due appreciation of the spirit in which learning should be sought and teaching given. There will be due provision made that all entering students shall by their previous training be able to take full advantage of the lectures and classes, just as provision is made for this at the South African College. But the doors of the institute will be closed to no one, however humble, who seeks such knowledge and is able to take advantage of it. This freedom for the acquisition of learning is a very different thing from the granting of diplomas to those who are unworthy. In its diplomas and certificates the institute will try to follow the highest standards, and in this we can hope for your friendly cooperation and support. For the present our mining students will derive incalculable benefit from the seal and stamp which you will set upon their university career, a seal which will derive its value from the high standard which you have ever striven to maintain amongst your graduates. You may be sure that whatever developments there may be in the future when our own university becomes an accomplished fact, the same safeguards for a university degree will be enforced for our university as there are for yours. No university degree can have any value which does not insist upon evidence of some amount of literary knowledge and include an acquaintance with more than one language on the part of its graduates—in a word, upon evidence of liberal education."

Referring to the fears expressed in some quarters in connection with a possible over-multiplication of universities, Prof. Hele-Shaw remarked :—"There is abundant evidence that the proportion of the population who are imbued with a love for higher learning and a determination to secure a university standard is far greater here than in the cities of the older countries. There may, possibly, exist some fear of what I have called a multiplication of universities—a fear that one university may arise and grow at the expense of another. I have heard this fear expressed in the instances with which I myself am personally acquainted ; but I have also seen this fear prove groundless. In the first place, it is known that the university which lowers its standard in the hope of attracting students thereby inevitably compasses its own downfall, and in the second place the remarkable effect of the institution of a new university seems to be that, whilst educational enthusiasm has been aroused in a new centre, a patriotic and zealous spirit has been rekindled in the old, and both universities have flourished where before one was only languishing."

THEORY OF AMPHOTERIC ELECTROLYTES.[1]

AMPHOTERIC electrolytes are those which are capable of acting as acids towards bases and as bases towards acids. One of the simplest types is that of the amino-acids, for example, glycine, $NH_2.CH_2.COOH$, which in virtue of the NH_2 group is an anhydrous base, whilst in virtue of the COOH group it is an ordinary organic acid. When such a substance is dissolved in water, it is ionised as acid, as base, and as the salt formed by their reciprocal neutralisation. From molecular weight determinations in aqueous solution it is found that in general the molecule is simple and not double, so that the unionised salt must be

$$\overline{NH_3.CH_2.COO}^{\rfloor}$$
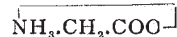
The theory of the ionisation and electrical conductivity of the aqueous solutions of amphoteric substances may be deduced by a consistent application of the law of mass action and Arrhenius's theory of electrolytic dissociation. If the anhydrous electrolyte is represented by the formula X, and the hydrated form by the formula $HXOH$, the ions found in the solution will be

$$\begin{array}{cccc} H+ & OH- & XOH- & HX+ \\ a & b & c & d \end{array}$$
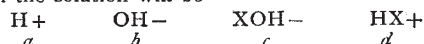
The letters beneath the formulæ represent the active masses for equilibrium of the corresponding ions. With regard to the active masses of the various forms of unionised electrolyte, it can easily be shown that these are in fixed ratios, whatever the concentration may be. We may therefore represent the sum of the active masses of the unionised forms by the letter u, and by considering the equilibrium of the different pairs of positive and negative ions, arrive at the following expressions :—

$$a = \sqrt{\frac{K + k_a u}{1 + \frac{k_b}{K} u}}$$

$$b = K/a$$
$$c = k_a u a$$
$$d = k_b u a / K,$$

in which K represents the ionic product for water, k_a the dissociation constant of the amphoteric electrolyte acting as acid, and k_b the dissociation constant of the amphoteric electrolyte acting as base. The value of K is well known, and k_a and k_b may be obtained from measurements of the degree of hydrolytic dissociation of salts of the amphoteric electrolyte. For feebly ionised electrolytes u is very nearly equal to the total active mass, and may be assumed to be so in the first approximation. It is therefore possible to calculate the concentrations of the various ions from a knowledge of the constants given above and of the total concentration. From these ionic concentrations and the corresponding ionic velocities the electrical conductivity of the solution may then be calculated.

This calculation has been made from Winkelblech's data for the amino-benzoic acids, and satisfactory agreement obtained with the observed numbers. For such substances the dissociation constants calculated from the conductivity by Ostwald's formula have been always found to be abnormal. The theory given above explains the abnormality, and accounts numerically for the variation in the "constant."

In general it may be said that in the case of amphoteric acids which have a ratio k_b/K of the order 100 to 1000, the Ostwald constant k_0 is greater than the true acid constant k_a at high concentrations, falls to a minimum considerably lower than k_a, finally to rise asymptotically to the true value k_a as dilution progresses. The conductivity at the high concentrations is chiefly due to the ionisation of the electrolyte as salt, whereas at the high dilutions it is mostly due to the ionisation of the electrolyte as acid. In consequence of this, the measurement of the conductivity of solutions of amphoteric electrolytes affords no criterion of their strength as acids. An amphoteric electrolyte in which the acidic and basic constants are equal would give solutions absolutely neutral at all concentrations, and possessing a molecular conductivity invariable with the dilution, thus differing from all simple acids, bases or salts.