

sent in use in various countries are not always those ordinarily adopted. In Japan, for example, the present standard of mass is the "Kwan," prototypes of which were recently standardised at Sèvres.

We can, however, cordially recommend the book, which should prove very useful.

J. A. H.

#### LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

##### Thermodynamic Reasoning.

In the address delivered by Principal Griffiths at York, which is printed in your issue of August 9, I read: "Prof. Armstrong remarks that it is unfair to 'cloak the inquiry by restricting it to thermodynamic reasoning, a favourite manœuvre with the mathematically minded.' He adds that such a course may satisfy the physicist but 'is repulsive to the chemist.' The inquiry, 'Why is the application of thermodynamic reasoning repulsive to the chemist?' naturally suggests itself."

This statement shows a strange misapprehension of my position. I have taken exception to the restriction of the inquiry to thermodynamic reasoning, not in any way to the mere application of thermodynamic reasoning. My objection was to formula worship. I still and shall ever object to it, for it is the bane of progress. As I said at York, physicists too nearly resemble the visitors to London who walk along the Strand and Shaftesbury Avenue and are content to look at the theatres from outside; they resemble those who admire the British Museum building but have no desire to examine the treasures within it.

If I did not misunderstand him, Mr. Whetham implied at York that it was enough for him that a certain thermodynamic expression was valid: what the condition termed osmotic pressure really is—whether a true pressure or whether, as I suggested, a negative pressure or thirst—mattered not a jot. A certain mathematical thermodynamic picture being painted, no other artist need apply. This does not seem to me to be the attitude a scientific inquirer should adopt. Whether I represent the opinion of chemists matters little: personally I am not willing to remain outside the Museum: I shall go inside, if possible, trusting that in some faint degree I may be able to appreciate the wonders within it.

At present, progress is not a little hampered by the fact that chemists and physicists cannot wander through the museums of nature looking eye to eye in complete sympathy with one another: surely we are destined to be the closest of friends; more should be done to cultivate an understanding; a confusion of tongues has arisen which keeps us apart: we must both strive to speak a simpler language. Together

"Let us inspect the lyre and weigh the stress  
Of every chord and see what may be gain'd  
By ear industrious and attention meet."

HENRY E. ARMSTRONG.

It is the strength and weakness of thermodynamical reasoning that it connects different phenomena without the aid of theories about the mechanism by which the connection is effected.

In the discussion at York, Prof. Armstrong put forward certain arguments in favour of the view that solution is a chemical phenomenon, and osmotic pressure due to an attraction of the nature of chemical affinity. He used these arguments in an attempt to invalidate van 't Hoff's thermodynamic theory, which shows that, from the observed solubility phenomena of volatile substances, it follows that the ideal osmotic pressure of a number of particles of such substances in a dilute solution must be equivalent to the pressure which the same number of particles would exert as a gas occupying the same space.

In my reply to Prof. Armstrong I pointed out that the

thermodynamic theory is quite independent of the particular view we may adopt as to the fundamental nature of solution, and the *modus operandi* of osmotic pressure. Osmotic pressure may, as van 't Hoff himself supposed, be due to the impacts of the dissolved molecules; it may, as Prof. Armstrong believes, be caused by chemical affinity; it may be produced by some other undiscovered cause. The thermodynamic reasoning avoids all such hypotheses, and connects directly the experimental facts of the solubility of gases with the osmotic pressure they would exert against a perfect semipermeable membrane in dilute solution.

I have never suggested that the ultimate nature of solution was a matter of no interest. It is the question of most supreme importance now outstanding in these subjects; but let us clear the issue before attacking it. We must recognise clearly that the relations indicated by thermodynamics and confirmed abundantly by experiment are among the established facts to be explained by a theory of the nature of solution.

It is for this recognition of the true position of the problem that I contend. The thermodynamic reasoning which connects the ideal osmotic pressure with experimental phenomena is not in question. That reasoning is confirmed by measurements of actual osmotic pressures and of freezing points. It can only be invalidated by a general attack on thermodynamic theory, such as that which was foreshadowed in Mr. Campbell's recent reconnaissance-in-force. I do not think any such attack has much chance of success. Osmotic phenomena seem to me to be entrenched in the strongest part of the vast lines occupied by the science of thermodynamics.

Cannot Prof. Armstrong agree to accept the thermodynamic reasoning as confirmed by experiment, and pass on to the further problem? Personally, I think that the evidence at present available is on the whole in favour of the chemical theory of solution and osmotic pressure—the theory which Prof. Armstrong supports; but there is work to be done before such a conclusion can be taken as established. May we not agree that it is better both for physicists and chemists to do such work than to waste their energies in attacking with inadequate artillery the well-fortified citadel of thermodynamics?

W. C. D. WHETHAM.

High Borran, Westmorland, August 21.

##### The Iron Arc.

WHILE carrying on some experiments with the electric arc between iron electrodes, one of my students, Mr. H. D. Arnold, noticed that there was a certain critical P.D. at which an abrupt change took place in the conditions of the arc. Subsequent investigation has shown that the effect is closely analogous to the "hissing point" of the carbon arc. How close the analogy is may be seen from the following remarks. If the iron arc is started with a large external resistance and maintained at such a length that the current is well below one ampere, it burns with little or no sound, and its appearance in the neighbourhood of the anode is very diffuse and ill-defined. As the external resistance is gradually decreased, the P.D. falls and the current rises until a certain critical value, depending on the length of arc and size of electrodes, is reached. At this point a very small decrease in external resistance suffices to cause a sudden increase in current and drop in P.D., precisely as with the carbon arc. At the same time the arc contracts, a bright spot appears on the anode, and a characteristic hissing sound begins. Further increase of current is accompanied by a *continued decrease* in P.D. The hissing stage, in fact, begins at quite a different point on the P.D.-current diagram from that in the case of the carbon arc. If the experiment is carried out in the reverse order, starting with a large current, the discontinuity is encountered again, but not until the current has been diminished beyond the value that it had at the beginning of the hissing stage. Indeed, with arcs of 6 mm. and more, the current on the hissing stage can with care be decreased until it is smaller than its previous largest value on the quiet stage. Thus there are two possible values of P.D. for the same current and length of arc, one corresponding to the quiet, the other to the hissing stage.