

exercise of a *common-sense check*." Too much weight may be attached to *graphic statics*, "but real utility is gained by making graphic methods a companion to (though not wholly a substitute for) analysis," and Prof. Minchin would assign a more conspicuous place to them in the text-books than they at present occupy. "Their essential merit consists in their furnishing visibly to the student the whole history of a magnitude throughout a series of variations in its circumstances." Prof. Minchin would also banish such "crude" terms as "power," "weight," in the equilibrium of machines: such forces might be called "efforts" and "resistances." Passing over one or two other subjects, we come to remarks on "illogical methods of teaching"; by such a method is here meant *a process which introduces considerations that are not essentially necessary for the purpose aimed at—considerations that can be seen a priori to be irrelevant*. The moral is pointed by the discussion of a question of usual occurrence in the text-books. The student should be able to be *critic of his data*, and "he ought to be taught to recognise clearly the object finally aimed at in any problem, and also to see what he must be given, and what he need not be given, in order to arrive at it." For this purpose Prof. Minchin purposely uses with his students some books which, *both in their data and in their methods*, are full of illogicisms. The finale comes in pointing out the desirability of making the student carefully distinguish between the *weight* of a body and its *mass*, and here he "comes down," if we mistake not, on an episcopal writer of works on dynamics, for a "remarkable misuse of language."

(3) Prof. Lamb's object is to suggest a new basis for the science of statics, and in the course of his paper he attacks certain principles and artifices, as "the transmissibility of force," and (in hydrostatics) the solidification of matter, and also "rigid" bodies. The "point of departure" which he suggests is that "the true and proper basis of statics is to be sought for in the principle of linear and angular momentum. Regarding statics as the doctrine of the equivalence of forces, I would define the word 'equivalent,' and say that two sets of forces are 'equivalent' when, and only when, they produce the same effect on the linear and on the angular momentum of any material system to which they may be applied: *i.e.* when they produce the same rate of change of momentum in any assigned direction, and the same rate of change of moment of momentum about any assigned axis." He believes that on examination the objections arising from the supposed difficulty and abstruseness of this mode of treatment, "will disappear, and that *on the whole* the method will be found to be really much simpler than that at present in vogue. The main difficulty is at the outset."

A brief but interesting discussion followed, enlivened as it was by a friendly passage of arms over the term *force of inertia*. R. T.

THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS

PART V.

1. Influence of Strength of Acid

IN the second part of this communication in NATURE, vol. xxv. p. 461, when treating of the charging of the cell, we pointed out that in the electrolysis of dilute sulphuric acid between lead electrodes, two totally different reactions might be obtained. The positive metal becomes thinly coated with lead sulphate when the current employed is of small density, but with lead peroxide when the density of the current is of greater magnitude. This latter action is, of course, what takes place in the ordinary formation of a Planté battery. The chemical change, therefore, which goes on at the positive electrode is to a certain extent dependent upon the strength of the current.

It appeared also of both theoretical and practical interest to determine whether the chemical change was also influenced by the strength of the acid employed. Our experiments consisted in passing a current of uniform strength, about 1 ampere, between electrodes of lead, 12 square inches in size, in varying strengths of sulphuric acid, and estimating in each case the amount of oxygen fixed by the positive electrode. We determined this for successive five minutes of time, and as such actions are not always very uniform, we made in each instance more than one experiment. The results are given in the following table:—

Strength of acid.	Expt.	Percentage of oxygen fixed.				Total.
		First 5 mins.	Second 5 mins.	Third 5 mins.	Fourth 5 mins.	
1 to 5	I.	38.1	28.6	28.6	33.3	128.6
	II.	39.5	30.2	25.6	30.2	125.5
1 to 10	I.	43.4	38.7	29.2	34	145.3
	II.	44.1	39.3	29.3	34.9	147.6
1 to 50	I.	48.3	39.6	35.3	22.4	145.6
	II.	46.2	43.9	23	30	143.1
	III.	54	40	35.3	35.5	165
1 to 100	I.	42	38.3	33.9	29.5	143.7
	II.	42.4	40	37.8	35.5	155.7
	III.	51.1	44.2	34.9	34.9	165.1
1 to 500	I.	46.6	32.6	27	27	132.6
	II.	46.4	27	27	18	118.4
1 to 1000	I.	90.6	81.1	76.4	57.5	305.6
	II.	90.8	77	72.3	63.1	303.2

It appears from this that the strong sulphuric acid (1 to 5) is not quite so favourable to the action as the more dilute (1 to 10), but that between this latter proportion and 1 to 500 there is no great difference in the amount of oxygen fixed, and therefore of corrosion of the plate. The appearance of the plate in every instance indicated the formation of only lead peroxide. With sulphuric acid diluted with 1000 parts of water, the amount of oxygen fixed, and therefore of corrosion, was at least doubled, while the chemical action was very different. On parts of the electrode, streaks of a mixture apparently of the yellow and puce-coloured oxides were seen. On other parts a white substance formed and was easily detached, falling in clouds into the liquid. Where this latter action took place, the plate was visibly the most corroded. This white substance gave on analysis SO₄ equivalent to 73.6 per cent. of lead sulphate, suggesting the idea that it was a basic sulphate of the composition 2PbSO₄,PbO, which would require 73.1 per cent. As the peroxidation of the lead is required, and the corrosion of the plate is to be avoided as much as possible, it is evident that this extremely dilute acid must be avoided. It has already been shown that if the sulphuric acid is entirely removed from solution, as sometimes happens in an accumulator, the lead is simply converted into the hydrated protoxide, and therefore corroded without any good effect.

2. *Function of Hydrogen*.—In the formation of a secondary cell, after the complete reduction of oxide or sulphate to metallic lead, bubbles of hydrogen gas are seen to escape from the lead plate. It has been assumed that a portion of this is occluded by the lead, or in some other way enters into association with it, and it has been

supposed that this hydrogen compound may play an important part in the subsequent production of electromotive force. It therefore appeared desirable to obtain experimental evidence as to whether hydrogen is so absorbed. The process we adopted for this purpose was founded upon the observation of Graham that hydrogen associated with palladium reduced ferri- to ferro-cyanide of potassium, and that generally in the occluded condition the element was more active chemically. We had previously ascertained that hydrogen associated with other elements, as platinum, copper, and carbon, was capable of reducing potassium chlorate to chloride. This method seemed to give trustworthy results, and therefore we applied it in this instance. As the result of several trials, however, we found that the amount of hydrogen associated with the reduced lead was almost inappreciable. Small as this quantity is, however, it is by no means impossible that it may be the cause of the exceedingly high electromotive force observed for the first few moments, on joining up a completely formed cell immediately after its removal from the circuit of the charging current. This, however, may be due, as Planté imagined, to the gaseous hydrogen itself. The principal if not the only function of the hydrogen of the water or sulphuric acid is therefore that of reducing the lead compounds.

By a totally different process Prof. Frankland has very recently come to the same conclusion as ourselves in regard to the exceedingly small amount of occluded hydrogen.

3. *Evolution of Oxygen from the Peroxide Plate.*—Planté noticed a small escape of gas from the negative plate of his cell immediately after its removal from the influence of the charging current. This he attributed to a decomposition of water by means of local circuits between the peroxide and the subjacent lead plate in contact with it.

The explanation we gave in our first paper (NATURE, vol. xxv. p. 221) of the local action which goes on at the negative plate does not account for the escape of any gas—either oxygen or hydrogen. We therefore thought it of interest to ascertain the nature, and if possible the origin, of the gas noticed by Planté.

We found that the escape of gas from a Planté negative plate was very slight, and soon ceased; but we observed that it became much more pronounced when the temperature of the electrolytic liquid was raised. In order to get a sufficient quantity of the gas for examination, we prepared a negative plate according to the procedure of Faure, and then heated it in dilute acid, with an arrangement for collecting the gas as it was evolved. The amount of gas was still very small in comparison with that of the peroxide, but a sufficient quantity was collected to enable us to ascertain that it was oxygen. We next heated some of the electrolytic peroxide apart from the lead plate, and again noticed a similar evolution of gas, which was also found to be oxygen. This shows, therefore, that it was not a result of local action.

The gas has generally some odour of ozone, and, on testing the dilute acid between the plates of a Planté cell, we always found traces of something that bleached permanganate of potassium, and which might be either ozone or peroxide of hydrogen.

The origin of the gas noticed by Planté may be easily attributed to the oxygen which always passes off in quantity from the peroxide plate during the process of "formation." It is only necessary to suppose that some of this becomes condensed on the peroxide, and is gradually eliminated from it when the surrounding conditions are changed. But the matter is capable of another explanation. If peroxide of hydrogen be really formed in the liquid, it will exert its well-known influence on higher oxides, namely, that of reducing them and itself at the same time. As a matter of fact, if peroxide of lead is dropped into peroxide of hydrogen oxygen is evolved.

4. *Temperature and Local Action.*—Planté has recently pointed out that an elevation of temperature facilitates the formation of his secondary cell (*Comptes Rendus*, August, 1882). The character of the chemical changes which took place at the negative plate led us to think it exceedingly probable that this increase in the rate of formation arose from an augmentation in the amount of local action. Experiment showed such to be the case. Pairs of similar negative plates on Planté's model were allowed to remain in repose at 11° C. and 50° C. respectively, and the formation of the white sulphate was visibly more rapid at the higher than at the lower temperature. The same is also true with negative plates prepared by Faure's process. Thus we found that two similar plates kept in repose for an hour, the one at 11° C. and the other at 50° C., formed by local action 2.6 and 7.4 per cent. of lead sulphate respectively. On two other plates the proportions were 7.6 and 9.5 per cent. respectively. These observations of course by no means exclude the idea that an increase of temperature may facilitate the other chemical changes that take place in the formation of a lead and lead-oxide cell.

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THE LION AT REST

THE illustration which we give on next page, from *La Nature*, is after a photograph of one of the lions in the Zoological Gardens, London. This photograph may be regarded as one of the numerous triumphs of instantaneous photography, valuable both to art and science. The original was rephotographed in Paris directly on wood, by means of a special collodion, at present much used. This has assured a perfectly faithful reproduction of the original, exhibiting all the characteristic details of the lion at rest. The illustration tells its own story.

ON THE RELATIONS OF THE FIG AND THE CAPRIFIG¹

THE relations of the fig and the caprifig, or the cultivated varieties of fig and the wild form of the Mediterranean region, have been variously explained by different writers, including those recent ones whose works are cited below. Intimately connected with this question is the process of caprification, so often and so circumstantially described by ancient and modern authors, amongst the later of whom we may mention Gasparrini. Graf Solms-Laubach's essay is an elaborate work of upwards of one hundred quarto pages, embodying the results of much research. Not the least interesting part is that treating of caprification, or perhaps we might say the manner in which fertilisation is effected. The author regards the cultivated edible varieties of fig as constituting one race, and the wild caprifig as another race of one and the same species; and the former as having developed from the latter under the influences of cultivation. Gasparrini, on the contrary, described them as distinct genera. Dr. Fritz Müller takes an altogether different view. He says it appears to him far more likely that the fig and caprifig represent, as Linnæus supposed, different forms, the male and the female, belonging together, and not proceeding the one from the other, but which developed side by side, before any cultivation, through natural selection. An examination of the facts adduced by Solms-Laubach himself seems to point to the correctness of Müller's view. But we will set them forth as briefly as possible, leaving the reader to judge for himself. The responsibility of their accuracy rests with the author whom we are quoting. It

¹ "Die Herkunft, Domestication und Verbreitung des gewöhnlichen Feigenbaums (*Ficus Carica*, L.)." Von Grafen zu Solms-Laubach. (Göttingen, 1882.)—"Caprificus und Feigentaum." Von Fritz Müller. *Komet*, xi. p. 306.—"Sulla Caprificazione, &c." G. Arcangeli. *Processi Verballi della Società Toscana di Scienze Naturali*, November, 1882.