two parts. The experiments start off with the commonly occurring phenomena of combustion, and lead up to the laws of chemical combination, the determination of chemical equivalents, vapour densities, &c.

Part II. consists of qualitative and quantitative analysis taken together, no attempt being made to separate the two. The results of the experiments are here carefully withheld from the student, and are given in the Key. A useful table for the detection of the positive radicles is published separately, and may be used in connection with this part.

The book can be recommended as a trustworthy one, and, apart from the novelty of the system adopted, as a storehouse of knowledge useful to the chemist, it will be appreciated by many a teacher.

The problems are actual examples met with in the laboratory, and appear to be free from the artificial exercises so common in text-books. It is also noteworthy that they, as well as the lectures, are concerned to a considerable extent with the energy changes as well as with the material changes which constitute chemical phenomena.

In glancing at the tables of physical constants to be found as answers in the Key, it is frequently noticeable that these magnitudes are given to an accuracy which is altogether fictitious. For example, to express heats of vaporization or absorption coefficients to one part in thousands of millions, or to give a boiling point such as that of bromine to one thousandth of a degree Fahrenheit, tends to create an erroneous idea of the accuracy with which such determinations can be made. In one or two instances the information is not quite up to date. Hydrofluoric acid, for instance, is still formulated H_2F_2 , and Bunsen's values for the absorption coefficients of hydrogen and oxygen are still given, although they have been superseded by the observations of Winkler and Timoféef. Van der Waals's work might have been included in the otherwise serviceable account of the kinetic theory of gases, and it is somewhat unfortunate that the author insists upon the narrow view that specific gravity has no other meaning than that which is perhaps more correctly attributed to relative density.

The printing and the woodcuts are hardly up to the standard usually attained in books of this kind.

J. W. R.

OUR BOOK SHELF.

Die Pflanze in ihren Beziehungen zum Eisen. Von Dr. Hans Molisch. Iron in its Relations to Plant-life. 8vo, 119 pages, with one coloured plate. (Jena: Gustav Fischer, 1892.)

AN interesting essay on the presence, function, and form of iron in plants, embodying the results of previous investigators and of the author's experiments and researches extending over several years. Though the outcome of much labour, Dr. Molisch regards it as preliminary to more extended inquiries, and the whole subject as being yet in its infancy. He discusses the determination of the presence in the vegetable cell of iron in loose combinations and in dense combinations, or what he terms the masked condition. He then describes the occurrence and distribution of iron in plants in loose and dense combinations, and enters somewhat fully into the description of a new method he claims to have discovered

for proving the existence of iron in the masked condition, even when it is present only in infinitesimally small quantities. This is done by soaking the objects one or more days or weeks in saturated aqueous liquor potassæ, and then, after quickly washing them in pure water, subjecting them to the usual reagents. He further claims to have proved that iron is not one of the constituents of chlorophyll. There is also a short chapter on healing vegetable chlorosis by the use of chloride of iron, sulphate of iron, and other salts of iron. W. B. H.

Up the Niger. By Captain A. F. Mockler-Ferryman (London: George Philip and Son, 1892.)

SEVERAL years ago complaints were made about the conduct of various British subjects in the territories placed under the Royal Niger Company. The British Government accordingly sent Major Claude Macdonald to inquire into the matter. He was accompanied by Captain Mockler-Ferryman, who in the present volume gives a full account of the proceedings of the Mission. During the entire journey, which extended over more than 3000 miles, nothing "of a blood-curdling nature" occurred, so that any one who is attracted to books of travel mainly by the chance of finding them full of sensational narratives, need not trouble himself with Captain Mockler-Ferryman's pages. On the other hand, those who like to read about remote regions and their native inhabitants, will find in this book much to interest them. The author is an accurate observer, and notes in a clear and unpretending style the facts by which his attention has been most strongly attracted. His descriptions of the native tribes of the Niger country, so far as he himself observed them, are particularly good, and will not only please the general reader, but be of service to ethnologists and anthropologists. A capital chapter on music and musical instruments, prepared from materials collected by the members of the mission, is contributed by Captain C. R. Day, and the value of the volume as a whole is much increased by a map and illustrations.

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.]

Density of Nitrogen.

I AM much puzzled by some recent results as to the density of nitrogen, and shall be obliged if any of your chemical readers can offer suggestions as to the cause. According to two methods of preparation I obtain quite distinct values. The relative difference, amounting to about $\frac{1}{1000}$ part, is small in itself; but it lies entirely outside the errors of experiment, and can only be attributed to a variation in the character of the gas.

In the first method the oxygen of atmospheric air is removed in the ordinary way by metallic copper, itself reduced by hydrogen from the oxide. The air, freed from CO_2 by potash, gives up its oxygen to copper heated in hard glass over a large Bunsen, and then passes over about a foot of red-hot copper in a furnace. This tube was used merely as an indicator, and the copper in it remained bright throughout. The gas then passed through a wash-bottle containing sulphuric acid, thence again through the furnace over copper oxide, and finally over sulphuric acid, potash, and phosphoric anhydride.

In the second method of preparation, suggested to me by Prof. Ramsay, everything remained unchanged, except that the first tube of hot copper was replaced by a wash-bottle containing liquid ammonia, through which the air was allowed to bubble. The ammonia method is very convenient, but the nitrogen obtained by means of it was $\frac{1}{1000}$ part lighter than the nitrogen of the first method. The question is, to what is the discrepancy due?

The first nitrogen would be too heavy, if it contained residual oxygen. But on this hypothesis something like 1 per cent. would be required. I could detect none whatever by means of alkaline pyrogallate. It may be remarked the density of this nitrogen agrees closely with that recently obtained by Leduc, using the same method of preparation.

On the other hand, can the ammonia-made nitrogen be too light from the presence of impurity? There are not many gases lighter than nitrogen, and the absence of hydrogen, ammonia, and water seems to be fully secured. On the whole it seemed the more probable supposition that the impurity was hydrogen, which in this degree of dilution escaped the action of the copper oxide. But a special experiment appears to exclude this explanation.

Into nitrogen prepared by the first method, but before its passage into the furnace tubes, one or two thousandths by volume of hydrogen were introduced. To effect this in a uniform manner the gas was made to bubble through a small hydrogen generator, which could be set in action under its own electromotive force by closing an external contact. The rate of hydrogen production was determined by a suitable galvanometer enclosed in the circuit. But the introduction of hydrogen had not the smallest effect upon the density, showing that the copper oxide was capable of performing the part desired of it.

Is it possible that the difference is independent of impurity, the nitrogen itself being to some extent in a different (dissociated) state?

I ought to have mentioned that during the fillings of the globe, the rate of passage of gas was very uniform, and about $\frac{1}{3}$ litre per hour.

RAYLEIGH.

Terling Place, Witham, September 24.

Recent Spectroscopic Determinations.

In the September number of the *Philosophical Magazine* Mr. Michelson has published determinations, by a most interesting method, of very close double and multiple lines. In any attempt to interpret his results, it is necessary to bear in mind the profound modifications which the internal motions of a gas—the rectilinear motions of the molecules between their encounters, as well as the motions going on within each molecule—had undergone within the Geisler's tubes upon which he experimented.

In a gas under ordinary circumstances the rectilinear journeys of the molecules take place indifferently in all directions, and where this is the case it follows from the well-known relation between the surface of a sphere and that of its circumscribing cylinder, that the effect of the velocities which happen to lie between v and $v + \delta v$ is to substitute for each line of the spectrum of the gas a band of uniform intensity and without nebulous edges, the width of which can be calculated. This width, for example, is .04 of an Ångström or Rowland unit (the tenthemetre), in the yellow part of the spectrum and for velocities of the molecules which lie in the neighbourhood of two kilometres per second, which is about the average velocity of molecules of hydrogen at atmospheric temperatures. Hence with all the velocities that prevail among the molecules, the effect of the rectilinear motions under ordinary circumstances is that each line will be symmetrically widened and rendered nebulous. To this effect Mr. Michelson calls attention.

But in the residual gas of a Geisler's tube through which electricity is passing, the case is altogether different. Here the rectilinear motions of the molecules are not alike in all directions, but preponderate in some: a state of things which must at least double the lines, and may introduce greater complications.

Moreover, different lines may be differently affected, since the behaviour of the gas varies according to its position between the electrodes; as is evidenced by the observed differences in the form and colouring of the striæ, &c., in the several parts of a Geisler's tube.

We must also be on our guard in another respect, when we attempt to interpret the results, since the distribution of the heat energy of a gas between the rectilinear motions of its molecules and the motions within the molecules, which in the case of ordinary gas is a fixed ratio, is certainly largely departed from in gas through which electricity is passing. Until the laws of the new distribution are understood, the temperature of the gas, judged of by its behaviour to neighbouring bodies, will give us little information.

It is to such events as are referred to above, or others which

like them may arise from the special circumstances under which the vapour of sodium was in Mr. Michelson's experiments, that we must apparently turn for an explanation of the doubling of the constituents of the principal pair of sodium lines which he has detected; since he found that "the width of the lines, their distances apart, and their relative intensities vary rapidly with changes in temperature and pressure."

The method of investigation which Mr. Michelson has so successfully applied appears to be by far the most searching means yet discovered of experimentally investigating the intricate and obscure phenomena which present themselves in Geisler's tubes, and we seem justified in hoping for great results from it.

G. JOHNSTONE STONEY.

9, Palmerston Park, Dublin, September 22.

Printing Mathematical Symbols.

EVERYONE who has had to correct printers' proofs of mathematical formulæ must be painfully alive to the pitfalls into which the non-mathematical compositor continually blunders. To such as know the extreme difficulty of getting such formulæ properly set up, there have doubtless occurred from time to time suggestions for such simplifications of notation as shall render the composition less liable to derangement. One most sensible step of the kind I allude to is the introduction by Sir G. Stokes of the solidus notation for quotients, whereby

$$\frac{dy}{dx} \text{ is now written } dy/dx.$$

The immediate purpose of this letter is not to propound any wholesale scheme of reform, but to advocate one other simple step, and to induce some of my *confrères* to give the world their own suggestions.

Exponentials are a continual stumbling-block to the compositor, and to the printer's reader, who, when he comes to an expression like

$$Ae^{-ax},$$

does his best to make it look a little straighter and turns it into

$$Ae - ax,$$

or into

$$Ae - ax,$$

or perhaps worse.

The reform I advocate is to write the thing as follows:—

$$A \exp[-ax],$$

the square brackets being possibly omitted in all cases when their omission would occasion no confusion. One gain in this rotation is the reduction of the whole of the symbols to one level, so not breaking the line of type.

Another useful reform, though one on which I fear the probability of agreement is less likely, is the use of the Continental notation for inverse trigonometrical functions, writing, for example,

$$\arctan x,$$

instead of

$$\tan^{-1} x$$

for the angle whose tangent is x . Our notation is not only liable to continual misprinting, but is very confusing to Continental readers, who again and again read the latter expression as meaning

$$(\tan x)^{-1}, \text{ or } \cotan x.$$

I have even seen it reprinted in a German technical journal as

$$\tan - ix.$$

SILVANUS P. THOMPSON.

Technical College, Finsbury, September 22.

A so-called Thunderbolt.

DURING a short storm in Liverpool this summer, I noticed one flash as peculiarly sharp and noisy, and subsequently in the correct bearing from my house the ground was reported as having been struck by a thunderbolt. I examined the place, which was on the greensward of a lake, where the ground was penetrated by a number of fairly clean-cut almost vertical holes down which a walking-stick could be thrust. People sheltering near the lake reported a ball of fire and a great splash up of the