HINRICHS' CHEMISTRY

The Elements of Chemistry and Mineralogy, by Gustavus Hinrichs, A.M. (Griggs, Watson, and Day, Davenport, Iowa, U.S.)

THIS is the second volume of Prof. Hinrichs' series of science instruction for schools. In the former volume the elements of Physics were given; this volume contains the elements of Heat, Chemistry, and Mineralogy, and will be followed by a third, called the "Students' Cosmos." The author has thrown himself entirely into the practical method of teaching the physical sciences—the student has first to perform an experiment, and then draw his own deductions from it. In chemistry, perhaps, more than in the other sciences, this system leads to the best results; for on all sides laboratory practice is recognised as essential to its true understanding. If, however, large laboratories and costly apparatus are required, its introduction in our schools cannot become universal. The author has, however, shown in this volume that by excluding special branches, a considerable knowledge of the elementary methods of laboratory practice may be furnished, almost free of charge, by any school to all its pupils. At a time when science instruction in our schools is attracting so much attention, a series of volumes like the present is peculiarly valuable, and thanks are due to Prof. Hinrichs for his bold effort to show how the physical sciences should be taught.

The subject "Heat" occupies two chapters. The first deals with the sources of heat, modes of heating, radiation and induction, thermometry, calorimetry, and fusing and boiling; the second treats of the relation of heat to mechanical work. These are extremely clear and practical; we think better than those which follow. The third chapter is on "Dissociation and Electrolysis." After a few examples of the splitting up of compounds into their elements have been studied, the student is led naturally to the definitions of elementary bodies, of compounds, and mixtures. The next chapter is confined to the elements and compounds, and some of the principles of chemical nomenclature; to this chapter we must certainly take exception, the author has introduced a novel and arbitrary classification of the elements, which, we think, will tend to confuse the student. He groups the elements into nine genera, giving the characteristic properties of each: thus we have the kaloids, analogous to potassium; caloids, analogous to calcium; cuproids to copper, and so on; under the last head we find classed, copper, silver, gold. We cannot see any reasons for such grouping, for neither in their chemical nor in their physical properties do these three elements correspond.

The author divides chemical substances into monaries, binaries, ternaries, and serials; the monaries are the elements themselves, the binaries the compounds of two elements, the ternaries of three, whilst the serials comprise organic bodies; there is, however, no reason in the author's definitions why the greater number of the serials should not be classed under the ternaries. The term "serials" the author has taken from the fact that numerous organic compounds can be classed together to form series of substances, differing from each other by a definite increment. The next chapter treats of the synthesis of acids and bases, and chapter 6 is devoted to chemical

processes. Under the head of "substitution," the quantitative relations of the elements to each other are brought out. We do not think, however, that the difference between the terms "atomic weight" and "equivalent" is by any means sufficiently defined. A considerable space is devoted to the phenomena of double decomposition and to the complex processes, such as fermentation, &c., which concludes the chemical portion of the work. A chapter on mineralogy follows, but on this it will be difficult to give an opinion, as the method the author uses is novel, but, according to his account, quite satisfactory. The book on the whole is most carefully written, so that the student cannot fail in his experiments provided he follows his instructions; these also are so given as to lead to economical and precise methods of working. At the end of the book a number of blank pages are left for the pupil to fill up with his notes of experiments performed, and results obtained, forming quite a new feature in this class of works. The chapter on the "Chemical School Laboratory" we should recommend to the notice of our teachers, as it gives a description of the author's system of teaching, which, we believe, has succeeded extremely satisfactorily in the case of physics, and, we trust, will be equally successful in chemistry.

OUR BOOK SHELF

The Figure of the Earth. By Archdeacon Pratt.
(4th Edition. London: Macmillan and Co.)

THIS is the fourth edition of a well-known book, of which we shall unfortunately not now have any more new editions from the hand of its lamented author. The book has grown much since its first edition as a separate work in 1860. The chapter on the attraction of table lands, mountains, oceans, &c., has been much enlarged since the first edition, and also the chapter on the determination of the figure of the earth by geodetic operations. A chapter, most valuable to the student of physical mathematics, is inserted on the determination of the ellipticity of the earth (considered as a body whose surface is one of its own equipotential surfaces) from pendulum experiments, the moon's motion, and the precession of the equinoxes, respectively. The student of this subject must carefully bear in mind that no observations taken exterior to the surface of the earth can throw any light whatsoever on the internal arrangement of its matter, inasmuch as, according to the well-known theorems of Gauss, there are an infinite number of ways in which that matter might be conceived as being arranged so as to produce the same external effect. The observations above noticed, however, are calculated to throw light on the question as to whether the surface may, within the limits of approximation, be considered as a surface of equilibrium.

In fact, it is known that in any event the external effect of the earth may be precisely effected by the distribution in a concentrated form of the whole matter of its interior over its surface.

The important proposition that any function, which does not become infinite within the limits considered, can be expanded in a series of Laplace's functions, is proved by Mr. Pratt in the text by rather a long method, in order to get over a certain apparent objection as to discontinuity. The following proof of that proposition seems short, and not open to objection.

Let A and B be two points on a sphere of centre O . Let the co-ordinates of any point R referred to A be ϕ and θ , where ϕ is the cosine of the angle between OR and OA ,

and q the angle between the plane AOR and a fixed plane. Let μ, ω , be similar co-ordinates of R referred to B , and let μ', ω' , be the values which μ and ω assume at the point A . Let $F(\mu' \omega')$ be a function of μ' and ω' , which, when μ' and ω' become μ and ω , may be written $F(\mu, \omega)$. If δS be an element of the surface of the sphere, whose radius we shall take as unity, then δS may be expressed by $-\delta p \cdot \delta q$, or by $-\delta \mu \cdot \delta \omega$, according as occasion requires.

It is obvious from spherical trigonometry that

$$p = \mu \mu' + \sqrt{1 - \mu'^2} \sqrt{1 - \mu'^2} \cos(\omega - \omega')$$

and that therefore in the expansion

$$\frac{1}{(1 + x^2 - 2x\mu\mu')^{\frac{3}{2}}} = 1 + P_1 x + P_2 x^2 + \dots$$

The quantities P_1, P_2 &c., satisfy Laplace's equations in μ and ω , and also in μ' and ω' .

Differentiating this equality, multiplying by $2x$, and adding, we get

$$\frac{1 - x^2}{(1 + x^2 - 2x\mu\mu')^{\frac{3}{2}}} = 1 + 3P_1 x + 5P_2 x^2 + \dots + (2n+1)P_n x^n +$$

Integrating each side of this equation over the whole surface of the sphere, and equating the results, we have

$$\int_0^{2\pi} \int_{-1}^{+1} \frac{1 - x^2}{(1 + x^2 - 2x\mu\mu')^{\frac{3}{2}}} d\mu d\omega = \int_0^{2\pi} \int_{-1}^{+1} (1 + 3P_1 x + 5P_2 x^2 + \dots) d\mu d\omega$$

The first of these two integrals is readily found to be equal to 4π , being thus independent of x .

$$\therefore \int_0^{2\pi} \int_{-1}^{+1} (1 + 3P_1 x + 5P_2 x^2 + \dots) d\mu d\omega = 4\pi$$

Now as x approaches unity, every term in the series whose limit is represented by the integral

$$\int_0^{2\pi} \int_{-1}^{+1} \frac{1 - x^2}{(1 + x^2 - 2x\mu\mu')^{\frac{3}{2}}} d\mu d\omega$$

becomes more nearly equal to zero, except the terms in the immediate vicinity of the value $p = 1$, which increase in value, i.e. in the neighbourhood of the point A . Hence, as we diminish x , the ratio of

$$\int_0^{2\pi} \int_{-1}^{+1} F(\mu \omega) \{1 + 3P_1 + 5P_2 x^2 + \dots\} d\mu d\omega \text{ to } \int_0^{2\pi} \int_{-1}^{+1} \{1 + 3P_1 x + 5P_2 x^2 + \dots\} d\mu d\omega$$

that is to $4\pi \cdot F(\mu' \omega')$ becomes continually more nearly a ratio of equality, since $F(\mu' \omega')$ is the value towards which $F(\mu \omega)$ continually approximates as we draw nearer to the point A . Hence we have in the limit

$$4\pi \cdot F(\mu' \omega') = \int_0^{2\pi} \int_{-1}^{+1} F(\mu \omega) (1 + P_1 + 5P_2 + \dots) d\mu d\omega$$

and since P_n satisfies Laplace's equation of the n th order in $\mu' \omega'$

$$\therefore \int_0^{2\pi} \int_{-1}^{+1} F(\mu \omega) P_n d\mu d\omega$$

also satisfies it, because $\mu' \omega'$ are constants so far as this integration is concerned. Hence $F(\mu' \omega')$ is expanded in a series of functions satisfying Laplace's equations.

JAMES STUART

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

The Volcanoes of Central France

THE eruptions of A.D. 458-460, whose showers of pumice or ashes reached and alarmed the city of Vienne, then the capit

of the chief State in Gaul, and led to the institution of the Rogations (now called Litany) and the "Rogation Days," cannot have proceeded from the province of Auvergne, as Mr. Green supposes (NATURE, May 16). That province, containing about half the French volcanoes, is the most distant of the three volcanic ones from Vienne, and moreover is held to have been quiescent in that age (as well as ever since); because the eminent writer, Sidonius Apollinaris, who had settled there, and wrote a poem on its scenery, betrays no knowledge of its volcanic phenomena. So, at least, Sir Charles Lyell has repeatedly insisted. It is true that, writing before the date of the Vienne calamities, his silence proves nothing; but as fully half the French craters are not in the Auvergne, but between that province and Vienne, namely, in either the Velay or Vivarais, within about fifty miles of that city, and ranged along almost a quadrant (the S.W. quadrant) of its horizon, there can be little doubt that some of them were the scene of the "portentous fires," and sources of the "Sodomitic showers" that alarmed the Burgundian capital, and led St. Mamertus to institute these fasts. Of Mamertus himself there remain no writings, and the memory of any historic eruptions in France appears to have died out from that very century to the present; though none in all history were better attested, none within many centuries of Pliny's even so well. For it is strange that no later chroniclers mention anything but the earthquakes and some fires of buildings; the sole authorities for the eruptions being their contemporaries, the above Sidonius and the bishop who succeeded Mamertus in his see, and these two being the sole men in Gaul of that generation whereof any document remains. The former writes to Mamertus himself a very fulsome, adulatory, but necessarily a materially true memoir of the facts; and the latter allusively recounts them in a sermon to the very flock among whom the observances had begun. It seems impossible to conceive better witnesses to any event whatever, and they are literally all the contemporary writers extant.

The late Sir Francis Palgrave appears the first modern to have disinterred this page of forgotten history, in the *Quarterly Review* of October 1844. See also a most extraordinary paper on it in the *Gentleman's Magazine* of May 1865, commented on by me in the *Reader* of the next month (p. 683). As the original passages, however, of Sidonius and Bishop Avitus have not been reproduced, I enclose literal translations of them, if you think they would interest your readers. The style of their time must be allowed to be detestable, but not quite without parallels.

E. L. GARBETT

"Sidonius to Lord Patriarch Mamertus, health! It is reported the Goths have advanced their camps on to Roman soil! To this kind of eruption we wretched Auvergnats are always the gate. For we afford to the enemies' malice peculiar satisfaction; because, as they have not yet marked their bounds from Ocean to Rhone by the course of the Loire, they (under Christ's mercy) find their sole hindrance from our opposition only. Indeed, the tracts and regions of the surrounding country the eager assault of their threatening power would long ago have devoured. But in this, our so bold and dangerous a resolution, we trust not in our hearts either to the crumbling face of ramparts, the rotten barrier care (*studium*), or the failing defence of sentinels for assistance, but are only soothed by the comfort of the Rogations introduced, of which you were the author; which, being to be founded and instituted, the Auvergne people has begun to practise, if not with equal result, certainly with not inferior zeal, and on this account does not turn its back to the surrounding terrors. For it does not escape our research (*latit nostram sciscitationem*) how, in the first times of these supplications being instituted, by the terrors of what manner of prodigies the city divinely committed to you was being emptied. For at one time the walls of the public fortifications were shaken down by the continual earthquakes; at another the fires, often attended with flame, were smothering (*tumulabant*) the frail roofs with a load of showered ashes (*superjecto favillarum monte*). Now the vast lairs (*stupenda cubitibus*) in the forum harboured the boldness (O portentous tameness!) (*pavenda mansuetudo*!) of deer. When you, amid that flight of the nobles and the common people, the state of the city being desperate, quickly had recourse to new imitations of the ancient Ninevites, lest your despair, too, should mock the divine admonition. And truly at that time you could the least distrust God without sin, after your experience of his mercies. For once, when a certain city had begun to blaze, your faith had glowed more than the fire," &c. (He proceeds to relate the extinction of a former conflagration by the prayers of Mamertus; but this