Smithsonian Physical Tables. Seventh revised edition. Prepared by F. E. Fowle. Pp. xlvi+450. (Washington: Smithsonian Institution, 1920.) Price 18*s.* net.

SINCE the sixth edition of this standard volume of tables was reviewed in NATURE for July 5, 1915, extensive changes have been made, in the form of new data on both new and old topics. The volume has grown to 450 pages, and the number of tables given from 409 to 579. The new tables include useful material dealing with astrophysics, meteorology, geochemistry, atomic and molecular data, colloids, photography, etc. A great improvement is the renumbering of the pages; in the sixth and fifth editions new matter was inserted without altering the paging, with the result that there was no logical sequence of tables. This fault has now been rectified, and the tables have been arranged in order according to subject. The volume can be obtained from the London agents for the Smithsonian Institution, Messrs. W. Wesley and Son, 28 Essex Street, Strand, W.C.2.

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.*]

The Late Srinivasa Ramanujan.

IN the notice contributed to the issue of NATURE for June 17 last, Prof. Hardy was unable to give any account of the late Srinivasa Ramanujan's early life, and made no attempt to describe his appearance or character. The June number of the Journal of the Indian Mathematical Society has memorial articles by Prof. P. V. Seshu Aiyar, of Madras, and Dewan Bahadur Ramachandra Rao, and the first of these gives biographical details that have not hitherto been published in England.

Ramanujan was born at Erode on December 22, 1887.[1] His mother, a shrewd and cultured lady who is still alive, was the daughter of a Government official at Erode, his father a cloth-merchants' accountant at Kumbakonam, and it was in the latter town that his boyhood was spent. As is usual with Brahmin boys, he was sent to school at the age of five; before he was seven he was transferred to the Town High School, and there he remained until 1904, leading an inactive life and building an astounding edifice of analytical knowledge and discovery on the foundation of Carr's "Synopsis of Pure Mathematics," the only book on higher mathematics to which he had access. Having matriculated already in 1903, he went from the Town School to the Government College at Kumbakonam, but in January, 1905, his progress was stopped, and a scholarship on which he was dependent forfeited, owing to a weakness in English of which those who recall his fluency and the range of his vocabulary in later life will be surprised to learn.

Of Ramanujan's next few years no clear account has come to my notice. After a stay at Vizagapatam, he joined the Pachaiyappa's College at Madras, but, failing in his first examination, he gave up the idea of taking a university course. A nomadic period, during which his own researches progressed, came to an end in the summer of 1909, when he married and returned to Madras in search of permanent employment. There Prof. Seshu Aiyar, who had seen something of him at Kumbakonam in 1904, gave him a letter of introduction to Mr. Ramachandra Rao, at that time district collector at Nellore. Possibly Ramanujan was too timid to make direct use of the letter; Mr. Rao's story follows in his own words:—

"Several years ago, a nephew of mine, perfectly innocent of mathematical knowledge, spoke to me: 'Uncle, I have a visitor who talks of mathematics. I do not understand him. Can you see if there is anything in his talk?' And in the plenitude of my mathematical wisdom, I condescended to permit Ramanujan to walk into my presence. A short, uncouth figure, stout, unshaved, not over-clean, with one conspicuous feature—shining eyes—walked in, with a frayed note-book under his arm. . . . He was miserably poor. He had run away from Kumbakonam to get leisure in Madras to pursue his studies. He never craved for any distinction. He wanted leisure; in other words, simple food to be provided for him without exertion on his part, and that he should be allowed to dream on.

"He opened his note-book and began to explain some of his discoveries. I saw quite at once that there was something out of the way, but my knowledge did not permit me to judge whether he talked sense or nonsense. Suspending judgment, I asked him to come over again. And he did. And then he had gauged my ignorance and showed me some of his simpler results. These transcended existing books, and I had no doubt that he was a remarkable man. Then step by step he led me to elliptic integrals, and hypergeometric series, and at last his theory of divergent series, not yet announced to the world, converted me. I asked him what he wanted. He said he just wanted a pittance to live on so that he might pursue his researches. It is a matter of considerable pride to me that I was in some way useful to this remarkable genius in his earlier days. In a year's time, I introduced him to Sir Francis Spring (the president of the Madras Port Trust), who gave him a sinecure post in his office."

The last two sentences conceal that, throughout the interval of a year, not only was Mr. Rao trying to find some scholarship for which Ramanujan's original work might qualify him in spite of failure in examinations, but he was also maintaining Ramanujan in Madras at his own expense.

At the Port Trust Ramanujan remained until Dr. G. T. Walker, on an official visit to Madras, was made acquainted with his history, and joined forces with Sir Francis Spring. Their combined attack on the University and the Government of Madras resulted in the creation of a research studentship, which was of sufficient value to set him wholly free, and secured him access to the lectures and the library of the university; he was in possession of this studentship when I met him in 1914.

To Prof. Hardy's account of his correspondence and my intervention I have little to add. My task was an easier one than I anticipated. From the Government and the University of Madras I had every encouragement. On the other hand, Ramanujan was ready to put complete confidence in me simply because to him and his friends I came from outside the official machine. The only cold water was thrown

[1] This is the year given by Seshu Aiyar, and the date is consistent with the undisputed statements that Ramanujan was twenty-six when he came to England and thirty-two when he died; I have no doubt that the date 1888 commonly given is due to a natural misinference from these last figures.

from the India Office in London, but my efforts had succeeded before this reached Madras.

Throughout his life Ramanujan kept religiously to a diet of vegetables, fruit, and rice, and in England, outside his own rooms, food and clothing were a continual trial to him. I have known him ask with unaffected apologies if he might make his meal of bread and jam because the vegetables offered to him were novel and unpalatable, and with a pathetic confidence he has appealed to me for advice under the discomforts of shoes and trousers. His figure was short, and until his health gave way it was stout. His skin, never of the darkest, grew paler during his stay in England. His head gave the impression, which photographs show to have been false, of broadening below the ears, which were small. His face was clean-shaven, with a broad nose and a high forehead, and always his shining eyes were the conspicuous feature that Mr. Rao observed them to be in 1910.

Ramanujan walked stiffly, with head erect, and his arms, unless he was talking, held clear of his body, with hands open and palms downward. In conversation he became animated, and gesticulated vividly with his slender fingers. He had a fund of stories, and such was his enjoyment in telling a joke that often his words struggled incomprehensible through the laughter with which he anticipated the climax of a narrative. He had serious interests outside mathematics; he was always ready to discuss whatever in philosophy or politics had last caught his attention, and Indians speak with admiration of a mysticism of which his English friends understood little.

Perfect in manners, simple in manner, resigned in trouble and unspoilt by renown, grateful to a fault and devoted beyond measure to his friends, Ramanujan was a lovable man as well as a great mathematician. By his death I have suffered a personal loss, but I do not feel that his coming to England is to be regretted even for his own sake. Prof. Hardy speaks of disaster because of the hopes he entertained. If he pictures Ramanujan as he might have been throughout a long life, tormented by a lonely genius, unable to establish effective contact with any mathematicians of his own class, wasted in the study of problems elsewhere solved, Prof. Hardy must agree that the tragedy averted was the greater. Shortly before he left England, at a time of great depression, Ramanujan told me that he never doubted that he did well to come, and I believe that he would have chosen as he did in Madras in 1914 even had he known that the choice was the choice of Achilles.

E. H. NEVILLE.

University College, Reading, December 7.

The Mechanics of Solidity.

THE letters under this title from Mr. R. G. Durrant, Mr. V. T. Saunders, and Dr. H. S. Allen (NATURE, December 2 and 23 and January 6) are very interesting and suggestive, but melting points are of little value in discriminating between the hard and soft varieties of the same steel, and molecular weights, volumes, and frequencies have not yet any very definite significance in relation to solid metallic mixtures. My initial proposal that certain simple measurements might with advantage be substituted for the complicated tests now used by engineers and metallurgists was a "practical," if myopic, one; it has evidently been misunderstood, so perhaps I may be allowed to state the case in greater detail.

By "solidity" I meant to imply all the properties covered by the adjectives strong, elastic, stiff, flabby, tough, hard, mild, brittle, and many others. Solidity may eventually be specified in terms of atoms and molecules, but the specification would be very complicated, and I cannot at present "take sanctuary among the atomists"; solidity may be referred to its origins or to its manifestations, and for the moment the latter course seems to be the only practicable one. Solidity may be analysed in various ways, but Hertz has explained the meaning of "strength" very clearly, and it is convenient to take strength as the starting point; solidity seems to comprise elasticity, strength, and something more, namely, the variation of elasticity and strength with deformation. Isotropic solidity appears to be a continuum which fades into fluidity; it would be very desirable to know how many dimensions define this continuum, but the problem of mechanical testing is rather simpler, viz. How many dimensions are important, and what is the best way to measure them?

For the convenience of readers of NATURE who are unfamiliar with current engineering practice I may refer to the recent report of the Steel Research Committee of the Institution of Automobile Engineers; this, of course, is primarily a report on certain metals, but incidentally it serves as a report on the tests employed. The procedure is as follows: Test pieces are cut to three standard shapes and broken under prescribed conditions; four different measurements are made on the first piece and one measurement on the second and third pieces. The second and third tests are each repeated three times, and Brinell measurements are made on all test pieces. The report represents practice of a very high standard, and the foregoing programme is carried out thrice for each of some two hundred mechanical varieties of twenty chemically distinct steels; the report records about ten thousand measurements in all, each of them involving considerable care and labour. I feel sure the committee would endorse my view that in certain tests the concordance of nine individual measurements leaves a great deal to be desired; whatever these tests may determine, they do not determine anything very accurately.

To obviate all possibility of misconception, I should state the proposed alternative plainly. Six simple mechanical properties of a metal—density, two elasticities, and their temperature coefficients—can be measured fairly easily and with some precision; the temperature coefficient of intrinsic energy makes a doubtful seventh. The connection between these properties and practical engineering is admittedly obscure, but in the writer's limited experience this is true also of some of the other tests. None of the six properties referred to are customarily measured, but the single one that is well known—the thermal coefficient of density—bears a decided general resemblance to a strength, the particular strength to which Hertz has appropriated the word "hardness." My suggestion is that these six properties, and possibly others, would be worth investigating, and that some of them may prove convenient indicators of mechanical consistency; they would certainly serve as indicators of uniformity, and it may be doubted whether the other tests do much more.

Both Mr. Durrant and Mr. Saunders refer to the question of definitions, and these are certainly required for many of the attributes of solidity; hardness, however, appears to be an exception, and has been defined by Locke, Hertz, and Clerk-Maxwell. A definition established in the seventeenth century and supported by such high authorities cannot lightly be set aside; it seems that Mr. Saunders is right, and that "Brinell hardness" is not hardness. Verbal difficulties of this kind beget confusion, but,