

passed the wider and higher would grow the tunnel in which you were groping your way. The walls of the tunnel would grow thicker at every step, and their thickness and stoutness would tell you that you were already in an artery, but the inside would be delightfully smooth. As you went on you would keep passing the openings into similar tunnels, but the further you went on the fewer they would be. Sometimes the tunnels into which these openings led would be smaller, sometimes bigger, sometimes of the same size as the one in which you were. Sometimes one would be so much bigger that it would seem absurd to say that it opened into your tunnel. On the contrary, it would appear to you that you were passing out of a narrow side passage into a great wide thoroughfare. I dare say you would notice that every time one passage opened into another the way suddenly grew wider, and then kept about the same size until it joined the next. Travelling onwards in this way you would, after a while, find yourself in a great wide tunnel, so big that you, poor little corpuscle, would seem quite lost in it. Had you anyone to ask, they would tell you that it was the main artery of the arm. Toiling onward through this, and passing a few, but, for the most part, large openings, you would suddenly tumble into a space so vast that at first you would hardly be able to realise that it was the tunnel of an artery like those in which you had been journeying. This you would learn to be the *aorta*, the great artery of all; and a little further on you would be in the heart."

In conclusion, we are sure that there is no book which could be more profitably placed in the hands of the youth of both sexes, as a means of intellectual training and general culture, than this small work of Dr. Foster's. It possesses the advantage of combining precise reasoning with information on a subject which is all-important in every-day life; a subject which, if more universally understood, would lead to the adoption, by all, of means for the healthy maintenance of life which are now as systematically ignored as they are misunderstood. The reader is referred to Prof. Huxley's "Elementary Physiology" for the discussion of many subjects which the space allowed and the age of the pupils make it necessary to omit in the work before us.

#### OUR BOOK SHELF

*Exposition Géométrique des propriétés générales des Courbes.* Par Charles Ruchonnet (de Lausanne). Troisième édition, augmentée et en partie refondue. (Paris, 1874.)

*Éléments de Calcul Approximatif.* Par Charles Ruchonnet. Seconde édition augmentée. (Paris, 1874.)

WE have read these works with interest and somewhat of surprise: with interest because the subjects are fairly interesting and are treated in the well-marked style which distinguishes the writings of French mathematicians; with somewhat of surprise that the subjects treated at such length should have met with such a large circle of readers as is indicated by the number of editions that have been called for. The first work on our list establishes many general properties of curves by means of first principles and by the use of infinitesimals. This mode of treatment, so far as we know, is confined in our own text-books to a chapter or two in Dr. Salmon's works, and it would be hard to find more than he has given in any other work. The author himself states that

this elementary knowledge will carry the student through the book with the sole exception that a more extended acquaintance with mathematics is required for an article devoted to the finding the distance between a curve and its osculating sphere in the neighbourhood of the point of contact. The author, too, claims the major part of the demonstrations as his own, though in some cases he has generalised results previously given, and in some cases has established known properties in a novel way.

The work is divided into two parts; the first treating of the tangency, curvature, and osculating circle of plane curves: the second part treats of the analogous properties for non-plane curves, and deals also with the polar surface, the osculating sphere, ruled surfaces, developables, and the osculating helix. There are five pages of plates containing eighty clearly drawn figures.

The "Calcul Approximatif" is concerned with numbers only. M. Ruchonnet considers that he has improved upon the processes given by previous writers as regards their generality and precision as well as the facility with which they are effected. There are six articles and two notes. In the preliminary observations, the writer's aim is concisely stated to be the turning of an expression composed of incommensurable numbers (incommensurables avec l'unité) into a decimal to any given degree of exactness. He here treats of *absolute* and *relative* error, and then proceeds to summation. In the third article, in applying his methods to multiplication and involution, he sketches out the contracted process of multiplication employed by Oughtred; then follow contracted division (reference made to Serret's "Arithmétique"), evolution, and functions of a single variable. Amongst the important additions in this edition, is a complete solution of the problem "Combien de chiffres exacts faut-il calculer d'un nombre pour pouvoir en extraire la racine *n*ième avec *n* chiffres exacts?"

Many illustrative selections might be made, but as these would not be of general interest, we content ourselves with recommending those who take an interest in either of the subjects discussed by M. Ruchonnet to taste and judge for themselves.

#### LETTERS TO THE EDITOR

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

##### Flight of Birds

IN NATURE, vol. x. p. 147, I observe a letter signed "J Guthrie," and dated from the Cape, on the subject of the Flight of Birds, and particularly on the "hovering" of birds. It appears that one of your correspondents had referred to my chapter on this subject in the "Reign of Law" as giving a satisfactory explanation of this phenomenon. Mr. Guthrie thinks, on the contrary, that what I have there said "requires no refutation;" which is not wonderful considering the entire misconception which he evinces of the explanation I have given. He quotes me as affirming that "by a proper arrangement of its wings and tail and the position of its body, a bird can, without muscular exertion, remain suspended in a horizontal air-current, provided the latter be of sufficient velocity." If I had said this I should have talked nonsense. But I have not said it, as your readers may see by referring to the page (170, first edition) to which Mr. Guthrie himself refers. What I have said is, that under certain conditions of strength of air-current a kestrel can maintain the hovering position "with no visible muscular motion whatever." Mr. Guthrie omits the word "visible," and probably has no idea of its force and meaning in the sentence referred to. The maintenance of the wings and tail in the proper position, and of the body at the proper angle, does in itself, of course, involve continuous and difficult muscular action, although it is not visible, just as a rope-dancer standing still in some tiptoe attitude may require immense muscular effort although no motion be visible, and although the whole aim, object, and effect of that exertion be to produce stillness, and not motion.