year by year, and also the greater tendency towards accurate results, call for a book containing all the various rules and tables relating to those parts of mathematical and mechanical science whose application most frequently occurs in the useful arts, and especially in engineering and practical mechanics. In this volume of moderate bulk, such a work has been provided. The use of algebraical symbols has been avoided as much as possible, excepting in those cases in which the rules cannot be clearly expressed without them.

The book is divided into ten parts. The first deals with arithmetic and mensuration, including tables of cubes, squares, logarithms, a summary of the rules in trigonometry, with tables of arcs, sines, &c., concluding with the measurement of areas of surfaces, volumes of solids, and lengths of curves, &c. Part 2 treats of the measures of different nations, with tables and rules relating not only to measures of angles, time, length, surface, &c., but to those of speed, heaviness, pressure, work power, &c. Engineering geodesy, distributive forces and mechanical centres, balance and stability of structures, and strength of materials are included in the next four parts. Part 7 relates to machines in general, and gives rules for the comparison of the motions of different parts of a machine, and for the designing of teeth of wheels, speed cones, &c., with rules relating to work at uniform and variable speed. Parts 8 and 9 treat of hydraulics and heat, together with the steam-engine. The former includes rules for flow of water, prime movers, propulsion of vessels, &c.; the latter consists of tables of elasticity, volume, and specific heat of gases, factors of evaporation, with rules relating to furnaces, boilers, expenditure of heat in cylinders, efficiency of strain, &c.

Part 10, written by Andrew Jamieson, has been revised and considerably extended, and consists of electrical rules, tables, and formulæ. The information has been brought up to date as much as possible, and many points of difficulty, such as directions of currents, magnetic force and motion, are made clear by means of illustrations. Electrical engineering symbols and units of measurement, heat, and light are first given. These are followed by various forms of Wheatstone bridges, apparatus for testing electric light cables, the wire-testing batteries on the General Post Office system, tables of resistance, general data of the different submarine cables and batteries.

In the appendix there is a useful diagram of the mechanical properties of steam, showing the absolute pressure in pounds per square inch, and volumes in cubic feet per pound of dry saturated steam, and the mean absolute pressure, in decimal parts of absolute pressure of admission. A complete index adds greatly to the value of the work; and we may say that the more one looks through the pages of the book the more one is struck by the large amount of useful information collected together in these 456 pages.

Colour. By C. T. Whitmell. (Cardiff: Wm. Lewis, 1888.)

THIS book is designed for the general reader, and is, on the whole, well suited to this class of person. The principal drawback it possesses is unquestionably the want of a good index, while the division into short numbered sections of in many cases a few lines only is very inconvenient, and produces a sensation of discontinuity of subject. Some parts are excellently done, notably the illustrations given of irregular reflection by turbid media, the description of colour produced by absorption, and the part dealing with colour-blindness. In connection with this last subject much extension of our knowledge would no doubt result from systematic observation of the progressive development of colour-blindness in cases of locomotor ataxy.

It is to be regretted that the author did not supply

coloured diagrams to at least some of the sections, or failing this it would be more suggestive in the diagrams of light transmitted through different specimens of coloured glass to shade the part representing the absorbed and to leave unshaded that representing the transmitted light. Some preliminary description of the optical apparatus employed would be also serviceable, *e.g.* in section 10 the reader is told the properties of a spectrum produced by a diffraction grating, no reference being made until much later, and then a very incomplete one, as to the principle involved in the formation of the spectrum.

The book is fairly up to date, containing as it does reference to Langley's bolometric observations and to König's researches on the theory of colour vision. Interesting cases are given of errors due to ignorance of scientific principles; and in view of the frequency of their occurrence—perhaps more noticeably from neglect of the effects of refraction than of the principles of colour—it is regrettable that manuals such as Church's, Rood's, or this, are not more generally read by painters.

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.]

Sailing Flight of Large Birds over Land.

IT gave me great pleasure to see, by Lord Rayleigh's letter in NATURE of May 9 (p. 34), that the remarks made by me some months ago on this subject were not made in vain.

Ever since 1863, the sailing flight of large birds (which is here very common) has been a subject of observation to me, and odd notes have been sent home to the *English Mechanic* and to the Aeronautical Society (see Sixteenth Report, 1881, pp. 10-17).

Mr. A. Baines, in NATURE of May 2 (p. 9), well describes the sustained sailing of the albatross, indicating what I take to be the *vera causa*, *i.e.* the rising, kite-like, when it sweeps round to meet the wind, the energy of motion being gained by descending *with it* along an incline. But this problem, as seen among the sea-birds, seems to be complicated by the possibility of lifting action due to the waves; and, in Mr. Baines's letter, by different velocities of the air near the sea surface and at elevations of 20 feet or so. Out here, these two features are not only eliminated, but we see the bird doing more work.

The sea-birds merely sustain for hours a given weight, say twenty pounds, without flapping the wings, whereas the land-birds lift this twenty pounds, in two or three hours, to a height of 1 or 2 miles vertically, as well.

The adjutants (*Leptotilus argala* and *nudifrons*), the cyrus, pelican, vultures of several kinds, and storks, habitually rise here during fine weather, if there is a wind. At first they rise by flapping the wings vigorously, and, when 200 or 300 feet up, gradually begin to sail in huge right- or left-hand spirals, rising 30 or 40 feet at each lap. When seen thus, the wings are rigidly extended, and tail spread, the primary wing-feathers distinctly separated, and a loud musical tone is heard as the bird sweeps round and round overhead. If low down, they can be closely studied through a binocular, but if at a great height, I generally use a telescope, 3" 5 O.G., and terrestrial eye-piece, power 40. With this latter I can follow them, either in a group or singly, until each is a mere speck, and the elevation can be fairly calculated, when the spread of wing is often 8 or 9 feet $\times$ 1½.

Our prevailing north-east wind, and also our south-west monsoon, are particularly steady air-drifts of, say, 5 or 6 to 10 miles per hour, and I should doubt very much, if, after 500 feet up, there is any variation in the speed at different heights. The lifting due to occasional waves should also here be out of the question, and under these conditions I would ask Lord Rayleigh where we could possibly obtain the "energy of position" if it is not from the kite-like action? In my former note, to which he refers, I think a small diagram illustrated the slow drift to leeward as the bird rose by sailing in spirals.

I should say, perhaps, that the birds maintain the kite-like incline, *all round the windward portion* of the spiral, thus

and appear to gain elevation in sweeping round while thus at an angle; at first facing the breeze, and as they sweep round being side on, as per diagram, the centrifugal element coming into play. If very low down, indeed, the bird can be seen to rise distinctly as it wheels round the windward edge of the curve, and reaches its greatest elevation just as it turns tail to wind. Then it seems to shoot along down a slight incline with wings horizontal, and in rounding the leeward part of the

spiral, the outer wing is again spiral, thus . The

speed of the bird so greatly exceeding that of the wind, renders this necessary to enable it to turn.

Viewed from below, the tracks look circular, and often vary in size a good deal.

In all cases, so far as I have seen, these birds when rising, as they sail round and round, make leeway, say a mile for every 1000 feet rise, or less.

They never rise on a straight course, though they often descend in a straight line, and, after a time, flocks that drift over the hills recover their position over the plains by descending to windward.

But in all these cases of land-birds rising steadily as they sail round and round, there is no possibility of lifting by waves, as at sea, nor yet differences in the *speed of air strata* every 20 feet or so, as they sail at all heights, from 500 feet up to 10,000 or more.

The problem is much more clearly seen, and more wonderful, than in the case of the albatross, and, as far as I can see, the explanation which I gave years ago is the only one feasible. The momentum gained in descending a given distance *with the wind* is expended in lifting the bird kite-like as it turns and *faces* the wind, on the shorter windward course, where also a certain amount of centrifugal reaction comes into play and does some of the work.

S. E. PEAL.

Sibsagar, Assam, August 8.

Bishop's Ring and Allied Phenomena.

Is there any connection between the sunset glows seen by Mr. S. E. Bishop in the Sandwich Islands (see p. 415) and the phenomena which have occurred lately in Western Europe? There has been for two months a feeble reappearance of a great corona round the sun. I do not know whether I can call it Bishop's ring, as it has generally been larger than that caused by the Krakatão dust, and also more dirty-looking in colour, and doubtless at a lower level. Bishop's ring itself had never altogether ceased to be visible about sunset and sunrise, but I had not certainly seen it at any time when the sun has had a considerable altitude for nearly two years, and then only in the clear Alpine air. On May 14 and August 26, 1888, there was indeed a great corona, but on the latter occasion the air was not very clear, so I concluded it probably had some other cause than volcanic dust; and there have been a few other occasions before that when I have had the same impression. On May 14, 1888, it is also questionable whether the circle was caused by volcanic dust.

The present corona appeared all at once on June 30 last, while I was at Macugnaga, at the foot of Monte Rosa; and since that date, both travelling in the Alps and here (since I came home on August 8) it has continued more or less visible at all times of the day when not obscured by mist or smoke, except from the afternoon of July 1 until the afternoon of the 2nd. It is plainest about sunset. It first appeared on cloudy streaks like very thin indefinite cirrus, but these disappeared during July 1. Since it appeared the sky has never been such a pure blue as it was before; this applies to all altitudes from sea-level to 10,000 feet.

I have not seen any remarkable sunset phenomena, so that it seems difficult to connect this circle with the phenomena noticed by Mr. Bishop a fortnight later than this commenced; still the connection is not impossible, as he mentions seeing the central (and by far the brightest) part of the corona.

Although it is improbable that the dust of Krakatão can have entirely settled to the ground, the above description will show that the present phenomenon can hardly be caused by it; but

there must be a very extensive diffusion of some kind of dust—it may be one of the kinds alluded to by Prof. Tyndall and others in the discussion which occurred in your pages last year.

Sunderland, September 21.

T. W. BACKHOUSE.

OBSERVATIONS OF TWILIGHT AND ZODIACAL LIGHT DURING THE TOTAL ECLIPSE OF THE SUN, DECEMBER 21, 1889.

THE attention of all friends of astronomy and meteorology, and especially of navigators on the ocean, and of meteorological observers in India and Mexico, is respectfully called to the fact that they may make valuable observations during the coming total eclipse of the sun. The observations referred to are of a most elementary character, and pertain to the phenomena of twilight and of the zodiacal light. The importance of the observations to be described was first appreciated by German meteorologists, and the following paragraphs are based upon suggestions made by Prof. Bezold and Dr. Zenker, of Berlin.

On December 22, 1889, at 47 minutes before noon, Greenwich time (which corresponds with 6 hours and 13 minutes a.m. of standard Eastern time) our globe becomes tangent to the long cone that constitutes the shadow of total darkness behind the moon, and we say that "totality has begun on the earth"; this occurs at a point in the Caribbean Sea, north of Venezuela, at about 15° N. lat. and $72\frac{1}{2}^{\circ}$ W. long. In about three hours and a quarter this zone of total eclipse has passed the earth; its last point of contact, or tangency, occurs at a point on the eastern coast of Africa at about $5\frac{1}{2}^{\circ}$ N. lat. and 49° E. long. The path of totality on the earth's surface between these two limits is a narrow belt, about 100 miles broad, and astronomers will station themselves at favourable localities in order to observe the phenomena visible immediately around the sun, but meteorologists and local amateurs residing entirely outside the path of totality can also do good work.

The accompanying diagrams, I., II., III., IV., will illustrate the conditions of the eclipse and the nature of the meteorological observations desired to be made. Thus in diagram I. we see the point R, or the locality where the totality begins to an observer on the earth; at that point the sun rises while it is totally eclipsed, and the band from R to P shows the path of the shadow as it flies eastward. Diagram II. takes up the path at its other end, and shows it still moving eastward from P towards S, where it finally leaves the earth, so that an observer at S sees the sun in his western horizon, but totally eclipsed as it is setting out of sight.

If we now imagine a vertical plane passing through the observer and the eclipsed sun, it will give us a section of the earth, its atmosphere, and the cone of darkness very much as shown in diagrams II. and IV. In diagram II. R represents, as before, the locality where the sun rises eclipsed, the moon is to the east of the observer, and the cone of darkness passes over him towards its apex, which is far off towards the west. Those who are located to the west of R, as at D, looking eastward, cannot see the sun because it is below their horizon; they can see only the light of the morning dawn where the sun is about to rise, but these observers, if they look directly toward the brightest part of the dawn, immediately over the sun, will, on this morning of December 22, find that they are looking right into the shadow of the cone, and will therefore observe that the light of the dawn is for a few minutes much feebler than usual.

Similarly diagram IV. shows the condition of things at the point S, where the observer at sunset has the cone of darkness immediately above him; observers to the east of his location, as at T, will be enjoying twilight, and as they look toward the west, immediately above the sun, they