January 19, 1832.

JOHN BOSTOCK, M.D. Vice-President, in the Chair.

A paper was read, entitled "On the Theory of the Perturbations of the Planets." By James Ivory, Esq. A.M. F.R.S., Instit. Reg. Sc. Paris., & Reg. Sc. Gotting., Corresp.

The methods hitherto employed by mathematicians for determining the variations which the elements of the orbit of a planet undergo in consequence of perturbation, and for expressing these variations analytically in the manner best adapted for computation, are found to depend upon a theory in mechanics, of considerable intricacy, known by the name of the *Variation of the Arbitrary Constants*. In seeking the means for abridging the severe labour of the calculations, we must separate the general principles on which they are founded from the analytical processes by which they are carried into effect; and in some important problems great advantage is obtained by adapting the investigation to the particular circumstance of the case, and attending solely to the principles of the method in deducing the solution. The author suggests the possibility of simplifying physical astronomy by calling in the aid of only the usual principles of Dynamics, and by setting aside every formula or equation not absolutely necessary for arriving at the final results.

The present paper contains a complete determination of the variable elements of the elliptic orbit of a disturbed planet, deduced from three differential equations, that follow readily from the mechanical conditions of the problem. In applying these equations the author observes, the procedure is the same whether a planet is urged by the sole action of the constant force of the sun, or is besides disturbed by the attraction of other bodies revolving round the luminary; the only difference being that, in the first case, the elements of the orbit are all constant, whereas in the other case they are all variable. The success of the method followed by the author is derived from a new differential equation between the time and the area described by the planet in its momentary plane, which greatly shortens the investigation by rendering it unnecessary to consider the projection of the orbit. But the solution given in the present paper, although it makes no reference to the analytical formulæ of the theory of the *Variations of the Arbitrary Constants*, is no less an application of that method, and an example of its utility, and of the necessity of employing it in very complicated problems.

January 26, 1832.

JOHN WILLIAM LUBBOCK, Esq. M.A. V.P. and Treasurer, in the Chair.

The reading of a paper, entitled "Experimental Researches in Voltaic Electricity", by the Rev. William Ritchie, LL.D. F.R.S. Professor of Natural and Experimental Philosophy in the Royal In-

stitution of Great Britain, and in the University of London, was commenced.

February 2, 1832.

WILLIAM GEORGE MATON, M.D. Vice-President, in the Chair.

Charles Octavius Morgan, Esq., Joseph Jackson Lister, Esq., William Gravatt, Esq., the Hon. William Francis Spencer Ponsonby, Captain Sir Samuel John Brooke Pechell, R.N., Frederick Madden, Esq., John Edward Gray, Esq., and Alexander Barry, Esq., were elected Fellows of the Society.

The reading of the Rev. Dr. Ritchie's paper, entitled "Experimental Researches in Voltaic Electricity," was concluded.

The author adduces many facts in refutation of the theory by which Volta endeavoured to explain the development of electricity in galvanic circles. He shows that the contact of dissimilar metals is not necessary for producing that effect, for galvanic action may be obtained by employing only one metal, if the two ends of the same copper wire be coiled into helices of different diameters, and immersed into dilute nitric acid. The experiments of Mr. Parrot of St. Petersburgh are cited as leading to results totally different to those on which Volta rested the foundations of this theory. The author points out several important marks of distinction between voltaic and common electricity, and denies that the latter is capable of passing into the former. He shows by an experiment that the free electricity developed by heat is independent of that developed by galvanic action. Chemical decompositions are effected in a totally different manner by voltaic and by ordinary electricity; for in the former case the two elements of the decomposed substance are found disengaged at the opposite poles, but in the latter they are developed at the same point, and appear more as the effect of a cleavage of the molecules by the mechanical agency of electricity. The author conceives that in a galvanic circle of zinc and copper with interposed water, the superior attraction of the zinc for oxygen produces an arrangement of the molecules of the water such that the particles of oxygen entering into the composition of each are all turned towards the zinc. This definite arrangement produces in its turn, by induction on the neutral electric fluid contained in the metal, a corresponding definite arrangement of the two electricities along the whole electric circuit. Hence electro-magnetic effects may be obtained without any chemical decomposition; this latter effect taking place only when the attraction of the metal for one of the elements of the fluid is greater than that between the two elements of the fluid: and upon this principle the author conceives that the phænomena of the secondary piles of Ritter, and those observed by M. de la Rive, may be explained. By adopting the theory of the successive decomposition and recomposition of each particle of fluid in the line of action, we avoid the necessity of supposing the transference of the disengaged element through the intervening

mass of fluid. Whatever circumstance favours the decomposition of the water, will also increase the power of the voltaic arrangement. Conformably to these views we find that all liquids whose component parts go to the same pole are non-conductors of voltaic electricity. A given section of a liquid is capable of conducting only a limited quantity of electric influence. It was also found by experiment that when sulphuric acid was employed, the quantity of electro-magnetic action in the connecting wire is exactly proportional to the quantity of water decomposed in the liquid part of the circuit. This quantity is, within certain limits, inversely proportional to the square root of the distance between the plates.

In the second part of this paper the author enters upon an investigation of the fundamental principle and laws of action of the voltaic battery. He calls in question the truth of the common theories of galvanism, which are founded on the supposition of electricity being accumulated in the poles of the battery before the circuit is completed, and of its actual transfer and continued circulation through the entire course of the circuit. In order to analyse the effect of a single galvanic circle, the author made the following experiments. A compound plate of zinc and copper soldered together was cemented into a trough, and two single plates of copper of the same size were cemented, one on each side of the former plate, into the same trough, so as to form a cell on each side of it; and the cells were filled with dilute acid. On connecting the extreme copper plates by metallic wires with a delicate torsion galvanometer, a certain deflection of the needle was produced. When two compound plates were placed between the terminal copper plates, the deflection was twice as great; when three were employed, it was three times as great, and so on. It is thence inferred that the voltaic effects of two batteries of the same length, and with plates of the same size, are directly proportional to the number of plates. By prosecuting this inquiry, the author finds that, within certain limits, the voltaic energies of two batteries, consisting of plates of the same size, and placed at equal distances, but differing in number, are very nearly proportional to the square root of the number of plates. This result was deduced both from the quantity of water decomposed by the apparatus, estimated by the quantity of hydrogen disengaged, and also by the electromagnetic effects, as measured by the torsion galvanometer. But when the number of plates is greatly extended, the above law of increase is no longer observed, the effect being less than in proportion to the square root of the number. By continuing to increase the number of plates, we at length reach a limit beyond which there is no increase of effect, but rather a diminution. So that if the voltaic power were represented by the ordinates of a curve of which the abscissa denoted the number of plates, the curve, from being at first a parabola, would afterwards deviate into a form approaching to that of an ellipse.

In the third part of the paper the author relates experiments which prove that every part of the galvanic circuit conducts the same quantity of electricity, whatever be the material, whether solid or fluid,

composing it; for the magnetic needle is deflected in an equal degree by every part. He succeeded in exhibiting the rotation of a piece of charcoal, and of a column of water, while transmitting voltaic electricity, round the pole of a magnet. Having noticed a difference of temperature in the fluid conductor in the vicinity of the two poles, he was led to investigate the cause of this phænomenon. A rectangular box being divided into three compartments by two partitions of bladder, and filled with water, and the wires from the two poles of the battery being inserted into the extreme compartment, the temperature of the water surrounding the positive pole was found to be higher than that surrounding the negative pole, and that in the middle compartment highest of all. These differences he ascribes to the cooling effects of the disengagements of the several gases at each respective pole, the volume of the hydrogen being double that of the oxygen, producing twice the effect. With metallic solutions, the reverse takes place, the effect depending in every case upon the relative specific heat of the substances disengaged at the two poles.

The reading of a paper, entitled, "On the Organs of the Human Voice," by Sir Charles Bell, Knt. K.H., F.R.S., was commenced.

February 9, 1832.

HIS ROYAL HIGHNESS THE DUKE OF SUSSEX, K.G., President, in the Chair.

A paper was read, entitled, "Some Remarks on an Error respecting the Site and Origin of Graham's Island." By Capt. W. H. Smyth, R.N. K.F.M. F.R.S.

The author rectifies an erroneous assertion, originating from the report of Captain Larmour, who in the year 1800, when commanding the Wassanaer, a troop-ship on the Egyptian expedition, thought he observed a shoal of four fathoms water with breakers, within a mile of the latitude and longitude of the new volcanic island. The author has determined, by his own observations, that no such reef exists in that spot, nor is the assigned place of this shoal near that of Graham's Island, which arose considerably to the eastward, from a depth of above a hundred fathoms below the surface of the water. A knoll, with only seven fathoms of water upon it, was discovered not far from the site of these reports. The Adventure bank extends from Sicily nearly to Pentellaria, where the water deepens at once from 76 fathoms to above 375 fathoms, at which no bottom was met with. But, even on the supposition that what Capt. Larmour imagined he saw was the result of a temporary subaqueous volcanic eruption, it could not have justified the assertion of there being breakers with four fathoms upon them; and still less does it afford any foundation for the hypothesis that Graham's Island was formed by the mere lifting up of such shoal.

A paper was also read, entitled, "Researches in Physical Astronomy." By J. W. Lubbock, Esq., M.A. V.P. and Treasurer R.S.