above-mentioned conjecture of the retrograde motion of the sap be founded, it would follow that in the subsequent vegetation the inverted would display a more vigorous growth than the proper end; and this accordingly was soon found to be the case, with this additional circumstance, that the parts beyond the buds on the inverted ends were observed to increase considerably, while the same parts on the proper ends not only withered, but even gradually died away.

In another experiment a number of cuttings of gooseberry and currant trees were planted, some in their natural erect, and others in an inverted position. Many of these, especially the gooseberry cuttings, failed altogether; but in those that survived, the same accumulation of wood was observed on the upper ends of the inverted cuttings as on the vine shoots: similar effects were likewise observed in inverted grafts of the apple-tree, and in some respects also in cuttings from the sallow-tree, where, however, they being of some length, the accumulation of wood did not take place at the summit, but about the base of the cuttings.

It will be needless to dwell minutely on these results, since they may all be deduced from the author's theory, which, in addition to what has been above stated, is, nearly in his own words,—that the vessels of plants are not equally well calculated to carry their contents in opposite directions; and that the vessels of the bark, like those which constitute the venous system of animals (to which they are in many respects analogous), are provided with valves, imperceptible indeed to our eye on account of their extreme minuteness, but whose effects in directing the course of the sap are sufficiently obvious.

The paper concludes with some strictures on the experiments described by Hale and Du Hamel, and the reasons why these naturalists did not arrive at the same conclusions which are here brought forward, and an experiment which illustrates some parts of the paper the author gave last year on the descent of sap in trees.

Analytical Experiments and Observations on Lac. By Charles Hatchett, *Esq. F.R.S.* Read April 12, 1804. [*Phil. Trans.* 1804, *p.* 191.]

A brief historical account of the substance here treated of is prefixed to this paper. Though long in use, especially in India, yet, except what we have lately learnt from Mr. Kerr and Mr. Saunders, few inquiries have hitherto been made concerning its mode of production, first discovery, its nature and relative properties. We now know that it is the nidus or comb of the insect called Coccus, or Chermes Lacca, deposited on branches of certain species of Mimosa and other plants; and that the kingdom of Assam furnishes it in the greatest quantity. There are four sorts of it:—1. The stick lac, being the substance or comb in its natural state, incrusting small branches or twigs. 2. Seed lac, or the same substance granulated, but probably prepared in some manner, it being deprived of a great part of its colouring matter. 3. Lump lac, formed from seed lac,

liquefied by fire, and formed into cakes. And, 4. Shell lac, being the original comb, liquefied in water, strained through a cotton cloth, and spread upon a junk of a plantain-tree so as to form thin transparent laminæ: this kind contains the least of the tinging substance, as may well be expected from the mode in which it is prepared.

Among the chemists who have hitherto analysed this substance, none deserve notice except M. Geoffroy; but our author's present labours render his investigations of little or no avail.

The first section of this paper treats of the effects of different menstrua on the varieties of lac, from which it appears that it is soluble in alkalies, and in some of the acids. And the second section contains an account of the analytical experiments made on stick, seed, and shell lac. From the ample series of facts herein contained, of which it is in vain to attempt a compendious abstract, we collect in general that the varieties of lac consist of four ingredients, namely, extractive colouring matter, resin, gluten, and a peculiar kind of wax; and that the resin is the predominant ingredient, insomuch that, strictly speaking, we ought to consider lac as consisting principally of resin mixed with certain proportions of a particular kind of wax, gluten, and colouring extract. The mean results of the experiments give the proportions as follows:—100 parts of stick lac are found to contain resin 68, colouring extract 10, wax 6, gluten $5\frac{1}{2}$, and extraneous matter $6\frac{1}{2}$;—seed lac, resin $88\frac{1}{2}$, colouring extract $2\frac{1}{2}$, wax $4\frac{1}{2}$, gluten 2;—and shell lac, resin 90·90, colouring extract $\frac{1}{2}$, wax 4, and gluten 2·80. Each of these ingredients, we must observe, has been separately and carefully analysed.

The third and last section contains a number of general observations, chiefly relating to the uses of this substance. From the whole of the experiments here related, it appears that although lac be indisputably the production of insects, yet it possesses few of the characters of animal substances; and that the greater part of its aggregate properties, as well as those of its component ingredients, are such as more immediately appertain to vegetable bodies. Its uses are various, and some of them important. The Indians manufacture it into rings, beads, and other female ornaments. When formed into sealing-wax, it is employed as a japan, and is likewise manufactured into different coloured varnishes. The colouring part is formed into lakes for painters; and as a dyeing material it is in very general use. The resinous part is employed to make grindstones, by melting and mixing it with about three parts of sand, or with a like proportion of powder of corundum for those stones which are used by lapidaries. We owe to Mr. Wilkins the information, that a peculiar and excellent kind of ink is prepared by the Hindoos of shell lac, dissolved in water by the mere addition of a little borax, and by adding to the solution a certain quantity of ivory- or lamp-black. This process has the further advantage of teaching us to prepare an aqueous solution of lac, which probably will be found of very extensive utility, especially in the preparation of varnishes and pigments, which, when perfectly dry, will not be easily affected by damp or water.

The opinion generally adopted by chemists, that acids and alkalies do not act upon resinous bodies, appears from this investigation to be altogether erroneous; since the chief ingredient of lac which we have seen is soluble in those menstrua, is now determined to be of a resinous nature.

Some hints are lastly given concerning the further uses that may be made of these preparations in various manufactures, especially in dyeing, and the preparation of colours: nor is it thought unlikely that medicine may derive some advantages from the application of the extensive series of acid and alkaline solutions of resinous substances, which till now were thought to be unattainable.

On the Integration of certain differential Expressions, with which Problems in physical Astronomy are connected, &c. By Robert Woodhouse, *A.M. F.R.S. Fellow of Caius College.* Read April 12, 1804. [*Phil. Trans.* 1804, *p.* 219.]

In the preamble to this paper the author states, that if the introduction of the new calculi, as they have been called, has extended the bound of science, it has also greatly increased its difficulties by their number and magnitude: and that whilst the differential forms, which can be completely integrated, occur only in few problems, the investigations in physical astronomy give rise to differential expressions which call forth all the resources of the analytic art, even for their approximate integration.

The main object of this paper is to give a method of computing the integrals of certain expressions which lead to the determination of the logarithms of numbers, and the lengths of circular arcs. In treating of one of these expressions, known by the name of Fagnani's Theorem, the author traces out the correspondence between the methods of computation, and the proportion of geometrical figures; the analytical method, by which the integral expressing the arc of a circle is computed, affording, when duly translated, the theorem for the tangent of the sum of the two arcs expressed in terms of the tangents of the arcs.

It is in vain to attempt, without the use of symbols, to convey any adequate, nay, even a faint idea of the various series, converging and diverging according to the value of one of the coefficients of the original expression, which lead to the conclusions that illustrate this mode of investigation. Suffice it to say, that among other uses, the method may be applied to expand the formula that occurs in estimating the perturbation of planets: and in this instance the author points out the series which would be most commodious, and which would converge most rapidly if the radii of the orbits of the two planets, whose perturbations are sought, were nearly equal.