also the remarkable correspondence existing between the optical properties resulting from this structure, and the phenomena of the circular polarization of fluids, which have been accounted for by the existence of molecules of a structure nearly similar.

The author proceeds to examine the action of these crystals in common, or unpolarized light; and concludes from his inquiries that each of their diameters polarized the light in the plane passing through itself and the direction of the ray; so that the whole emergent light consists of equal portions polarized in every plane, and according to every diameter of the circle. This action is similar to that which would be exerted by an assemblage of an infinite number of pieces of tourmaline cut into the form of infinitely small sectors, in the direction of the axis, and disposed as radii in a circle. The author considers it probable that the tourmaline itself is an aggregate of acicular crystals of this description, disposed in a direction parallel to its axis, and being in optical contact, as well as in perfect mechanical cohesion.

In a postscript to this paper, an account is given of a new species of Dichroism in crystals, to the discovery of which the author was led by applying to them his peculiar method of observation with polarized light. In these experiments the crystals themselves perform the office of the analysing plate, acting on light previously polarized, and transmitted through a plate of mica. Under these circumstances, the crystals of borax, described in the first part of the paper, when examined with a lens of moderate power, appear beautifully coloured with two complementary colours, according to the position of their axes. These experiments tend to confirm the views of Sir David Brewster and others as to the general cause of the dichroism of crystals, which is ascribed to a difference of absorptive energy in different directions with relation to their axes; arising from a difference of elasticity in these respective directions.

May 19, 1836.

RODERICK IMPEY MURCHISON, Esq., Vice-President, in the Chair.

A paper was read, entitled, "On the valuation of the mechanical effect of Gradients on a line of Railroad." By Peter Barlow, Esq., F.R.S.

The exact amount of the influence of ascents and descents occurring in the line of a railway on the motion of a load drawn by a locomotive engine having been differently estimated by different persons, the author was induced to investigate the subject. A few observations are premised on the erroneous assumptions which, he conceives, have in general vitiated the results hitherto deduced. The first of these is that the expenditure of power requisite for motion is equal to the resistance to traction; whereas it must always greatly exceed it. No account, he remarks, has been taken of the pressure of the atmosphere on the piston, which the force of the steam has to overcome before it can be available as a moving power. Another source of error has been that

the statical and dynamical effects of friction have been confounded together; whereas they are the same in amount only when the body is put in motion by gravity; but not when it is urged down an inclined plane by an extraneous force. In the latter case these effects are no longer comparable; friction being a force which, in an infinitely small time, is proportional to the velocity, while that of gravity is constant at all velocities; or, in other words, the retardation from friction is proportional to the space described, while that from gravity has reference only to the time of acting, whatever space the body may pass over in that time. It is an error to assume that the mechanical power of the plane is equivalent to a reduction of so much friction; for the friction down the inclined plane is the same as on a horizontal plane of the same length, rejecting the trifling difference of pressure; and the whole retardation in passing over the plane, or the whole force required to overcome it, is the same at all velocities, and by whatever force the motion is produced; but the assisting force from gravity is quite independent of the space or of the velocity.

In the investigations which the author has prosecuted in this paper, he assumes that equal quantities of steam are produced in the same time at all velocities; and he adopts for his other data, those given by Mr. Pambour in his Treatise of Locomotive Engines. He deduces a formula from which, the speed on a level being given, we may compute the relative and absolute times of a train ascending a plane; and consequently also the ratio of the forces expended in the two cases; or the length of an equivalent horizontal plane; that is, of one which will require the same time and power to be passed over by the locomotive engine as the ascending plane.

The next objects of inquiry relate to the descent of trains on an inclined plane, and comprise two cases: the first, that when the power of the engine is continued without abatement; and the second, that when the steam is wholly excluded, and the train is urged in its descent by gravity alone. The author arrives at the conclusions, that in the first of these cases, when the declivity is one in 139, the velocity, on becoming uniform, will be double that in a horizontal plane: and that for a declivity of one in 695, the uniform velocity of descent will be one fifth greater than on the horizontal plane; and this, he observes, is perhaps the greatest additional velocity which it would be prudent to admit. A plane of one in 695 is therefore the steepest declivity that ought to be descended with the steam-valve fully open; all planes with a declivity between this and that of one in 139 require to have the admission of steam regulated so as to modify the speed, and adjust it to considerations of safety; and lastly, all planes of a greater slope than this last require, in descending them, the application of the brake.

A paper was also read, entitled, "On the application of Glass as a substitute for metal balance-springs in Chronometers." By Messrs. Arnold and Dent. Communicated by Francis Beaufort, Esq., Captain R.N., F.R.S., Hydrographer to the Admiralty.

In their endeavours to determine and reduce the errors arising from