Monday, 18th March 1850.

The Right Rev. BISHOP TERROT, V.P., in the Chair.

The following Communications were read :—

1. Note regarding the American Electric-Observing Clocks.
By Professor Piazzì Smyth.

The object of this communication was chiefly to exhibit a specimen of the register of the electric chronograph, wherein the second's beats of two clocks were marked side by side, one going nearly to sidereal time, and the other to solar; and the length of a second's interval on the paper was so great, and the accuracy of the punctuation such, that the minute acceleration of the one clock on the other could be registered almost from second to second.

The electric register can be applied with ease to any clock, and at any distance from the recording apparatus; and two or more clocks, or they may be simple pendulums, can be made to register their vibrations on the same slip of paper.

The author pointed out how this method might be made available for determining the density of the earth, by observations on the shores of the Bay of Fundy, during the rise and fall of the enormous tides which occur there. He likewise mentioned several purposes to which Lieutenant Maury, U. S. N., proposed to apply the electric chronograph; amongst others, to determining the height of mountains, as he thought that the accuracy capable of being attained in determining the time of vibration of a pendulum in this manner, was so extreme, that the method might be safely applied to such problems.

2. Account of a Remarkable Meteor, seen 19th December, 1849. By Professor J. D. Forbes.

“ On the evening of the 19th December 1849, whilst walking near the southern part of Edinburgh, about fifteen minutes past five. Greenwich time (as I afterwards estimated), I observed a meteor, fully brighter than Venus at her average brilliancy, moving from W. towards N., parallel to the horizon, elevated 15° above it, and followed by a distinct luminous train. This angle was subsequently

taken by estimation by daylight, with the aid of a theodolite; and the compass-bearing of the meteor, when first seen, ascertained in the same way, must have been 47° W. of N. When it bore 29° E. of magnetic north, it was observed to have divided into two, the one part following the other at some distance; and I soon after lost sight of it in the obscurity of the smoke of the town. When it split, its altitude was estimated at 6° . It thus described an arc of no less than 76° , in doing which it occupied, as I roughly estimated, about 15 seconds, or possibly more.

“ Having sent a short notice of the appearance of the meteor to the *Courant* newspaper, I received from many quarters accounts of its having been seen under circumstances remarkably similar to those just described. I believe that nearly forty communications on the subject have reached me from places included between Longford, in the centre of Ireland, to near Bervie, in Kincardineshire, a distance of above 300 miles, in a direction nearly NE. and SW., whilst in a perpendicular direction, or from NW. to SE, the range of observation has been comparatively small; for I have received no information from beyond Renfrew, in the one direction, and Durham in the other; being about 140 miles distant in a straight line. The meteor was seen at Longford, in Ireland, 74 miles west of Dublin, but not in Dublin itself. It was seen at Belfast, between Carlisle and Gretna at Stewarton in Ayrshire, at Johnstone, at Paisley, Renfrew, and by many persons in Glasgow and the neighbourhood. It was also generally seen in Edinburgh, in East Lothian, near Melrose, and at Durham, as already mentioned. Further north, I have received accounts from Crail, St Andrews, Dundee, Perth, and Johnshaven to the north of Montrose.

“ The greater number of these communications concur in estimating the direction of the motion of the meteor to have been from SW. to NE., although, as might be expected, they vary excessively as to its distance and magnitude; being described by some persons as only 50 or 100 yards off, and as large as the moon; by others, as a ball of 9 inches in diameter, or the size of a large egg. One person only professes to have heard a sound. The time during which it was seen was variously estimated. At Longford, by Mr Curtis, 20 sec.; at Glasgow, by Mr Stevenson, at 20 sec.; at Johnstone, by Mr Cunningham, 15 sec.; at Perth, 15 or 20 sec.; at Durham, by Mr Carrington, 30 sec.; at St Andrews, 15 seconds according to one

observer, and 18 to 21 seconds according to another ; at Johnshaven, $\frac{3}{4}$ ths of a minute. The hour of the appearance of the meteor, in most of the descriptions, is stated at between 5h. 10m., and 5h. 16m.

“ The arc of the horizon which it was seen to traverse depended, of course, on the point where the meteor first caught the observer’s eye. At Granton, it was traced by Professor Kelland through 125° of azimuth ; at Perth, 130° ; at St Andrew’s, 74° ; at Edinburgh, 76° ; at Durham, 65° ; at Glasgow, from 60° to 70° . The division of the head or nucleus into several parts, and, first of all (in most cases), into *two*, has been noticed with remarkably slight variation ; consequently, the explosion of the meteor marks a well-determined point in its path. The separation was specially noticed at Edinburgh, Granton, Glasgow, Renfrew, Melrose, Haddington, Johnshaven, Perth, Durham, St Andrews.

“ In a majority of cases a luminous train was observed ; and I am confident, that the existence of this train, which has been estimated at from 2° to 3° long, cannot be questioned. Dr Adamson, however, especially remarked that no train was to be seen at St Andrews.

“ On revising the whole accounts, it does not appear that any of them can be relied upon, for ascertaining the position of the meteor in space, except the observations of Mr Carrington of the Durham observatory ; of Professor Kelland, Mr Stirling, and myself, at Edinburgh ; of Dr Adamson and another observer, communicated by Professor Fischer of St Andrew’s ; of a young gentleman at Perth, communicated by Thomas Miller, Esq., Rector of the Perth Academy ; and of A. D. Stevenson, Esq., and W. Gourlie, Esq., junior, at Glasgow. My inquiries were chiefly directed to the two following points : *first*, the angular elevation of the meteor in the NW. quarter of the heavens, where it is admitted by all that its path appeared almost horizontal ; *secondly*, to the bearing of the meteor at the instant of explosion.

“ At Durham, Mr Carrington saw the meteor first when the bearing was true NW., the altitude (by theodolite) was then 10° , or not exceeding 11° ; when it burst, it was due N. (true), and continued to move 10° or 12° further before it disappeared. Professor Chevallier, who obligingly communicated these results, states that the meteor appeared rather to rise as it approached the north, but with a doubt. This supposition, however, appears inadmissible, from the unanimity of the other accounts.

“ At Granton, near Edinburgh, Professor Kelland caught sight of the meteor a little to the N. of the moon, and several diameters below it. This corresponds, by after estimation with a theodolite, to 75° W. of magnetic N., and an altitude of 12° . Professor Kelland thinks that it rather rose afterwards. It split into two at 20° E. of magnetic N., having then an altitude of only 5° ; it continued for a considerable time bright, then began to fade, as if by the effect of distance, and also to separate into several parts: it was finally lost sight of 50° E. of magnetic N. (this bearing is well ascertained), with an altitude estimated at only half a degree. The position and circumstances of these observations, made at an elevated station above the Frith of Forth, were eminently favourable.

“ Mr J. Stirling, civil engineer, looking up North Hanover Street, Edinburgh, saw the meteor separate into two parts; the bearing he afterwards estimated at 25° E. of magnetic N. (the probable error not exceeding 1°), and the altitude at $8^{\circ} 30'$, certainly not exceeding 9° .

“ I think we may conclude, that at Edinburgh the meteor attained a maximum elevation of 15° (that mentioned in the commencement of this paper), since it no doubt rose after Professor Kelland first saw it to the S. of the true W., with an altitude of only 12° . The course of the meteor was evidently such as to be nearest the spectator when in the true NW. or WNW.

“ The place of the meteor when it burst stands thus :—

Kelland, N. 20° E. (mag.)	Alt. 5° .
Stirling, N. 25° E.	Alt. $8^{\circ} 30'$.
Forbes, N. 29° E.	Alt. 6° .

“ The average is almost 25° E. of N., or about 1° W. of the true meridian, the variation being nearly 26° . The mean of the three observations of altitude would be $6^{\circ} 30'$; but admitting Mr Stirling's to be entitled to the greatest confidence, we may suppose it 7° , or possibly a little more.

“ At St Andrews, the meteor was seen by Dr Adamson, when riding in a northerly direction, on the Largo road. Professor Fischer was so kind as to accompany him afterwards to the spot, and to reduce his observations with all the accuracy of which they were capable. It was first noticed when bearing $8\frac{1}{2}^{\circ}$ W. of magnetic N., and disappeared at $42\frac{1}{2}^{\circ}$ E. of N.; the altitude was conjecturally

stated as between 14° and $18\frac{1}{2}^{\circ}$, and it appeared to move horizontally, but rather declining towards the N.

“ After describing three-fourths of its course, it split into two parts, which went on close together for a little, then broke into four or five, became dull red, and rapidly disappeared ; the separate pieces travelling on together until the last.

“ Another intelligent observer near St Andrews, whose evidence was taken by Mr Fischer, first saw the meteor $29\frac{3}{4}^{\circ}$ W. of magnetic N., and estimated the point where the meteor burst at 44° E. of N. ; but this last number coincides so closely with Dr Adamson's estimate of the point of final disappearance, that it is perhaps allowable to suppose, that this second observer had mixed up these two events in his description. Dr Adamson's statement, that one-fourth of the arc which he saw was described after the meteor had split, would give an azimuth at that moment of almost 30° E. of N. magnetic, or 4° E. of N. true, as Mr Fischer determined the magnetic declination to be about $25^{\circ} 46'$. The altitude of the meteor, as seen by this observer, appears not to have exceeded 15° (the same as at Edinburgh) ; which number we shall therefore adopt.

“ At Perth, the passage of the meteor was seen from the North Inch, by a young gentleman of intelligence, whose observations were reduced to numbers by Mr Miller, Rector of the Perth Academy, who was so good as to accompany him to the spot, and take the angles with a theodolite. Its bearing, when first seen, was 46° S. of W. true ; its angular altitude was at that time only $3^{\circ} 30'$. This is by far the most southern azimuth which has been observed. Its bearing, when it disappeared, was 6° W. of N., but it was then lost in a cloud. If I understand right, it had, by this time, separated into fragments. Its apparent altitude, in the middle of its course, was about $17^{\circ} 30'$. These observations, extending over an arc of 130° , taken along with Professor Kelland's, clearly demonstrate that the meteor appeared with a very low altitude in the SW. quarter of the heavens, and disappeared in a similar way in the NNE., attaining its greatest elevation about WNW. (true.)

“ At Glasgow the meteor was very generally and well seen. Mr William Gourlie junior saw it move from SW. to NNE., over an arc of 60° or 70° , and divide into two, when it bore 40° E. of magnetic N. He estimates its greatest elevation at 30° , and that it

decreased to between 15° and 17° , or even less, at the time of its separation. He adds, that he is not much accustomed to such observations. Mr A. D. Stevenson, living in South Portland Street, Glasgow, saw the meteor moving along, at a height just sufficient to clear the chimney-tops, on the west side of the street, an elevation which he afterwards estimated, as he states, with considerable accuracy at 28° . I have received farther and more minute accounts of the appearance of the meteor from Mr Stevenson, who has been most kind and intelligent in his communications; and my friend Mr James Peddie has verified the accuracy of Mr Stevenson's observations beyond the possibility of mistake. It appears that the meteor passed quite clear of a stack of chimneys on the opposite side of the street, which would give it a well-defined minimum altitude of $25^\circ 41'$; but Mr Stevenson is of opinion that it rose more than 2° higher, or to not less than 28° (perhaps even to $28^\circ 21'$); when it was highest, its bearing was $52\frac{1}{2}^\circ$ W. of N. (magnetic), and it disappeared from his view when it bore $40^\circ 27'$ E. of magnetic N. *It was then decidedly single.* Now, this bearing coincides with that at which Mr Gourlie observed it to become *double*; and, consequently, the limit towards the N. of this event is severely defined.

“ The following Table contains the most definite of these observations, and the azimuths are all reduced to the true meridian :—

	Greatest Altitude.	True Azimuth when first seen.	True Azimuth of disap- pearance.	Arc ob- served.	True Azimuth of first explosion.	Altitude at first ex- plosion.
Durham,	$10^\circ 30'$	N. 45° W.	N. 12° E.	57°	N.	
Edinburgh,	15°	W. 11° S.	N. 24° E.	125°	N. 1° W.	7°
St Andrews,	15°	N. 55° W.	N. 16° E.	71°	N. 4° E.	
Perth, .	$17^\circ 30'$	W. 47° S.	N. 7° W. (in a cloud)	130°	?	
Glasgow,	28°			$100^\circ?$	N. 14° E.	15°

Remarks on the Observations.

“ 1. On the whole, these observations are not consistent, and cannot (I conceive) be cleared up without additional and accurate ones, which it may now be too late to procure. The central group of stations, Edinburgh, Perth, and St Andrews, are sufficiently accordant, and indicate that the path of the meteor must have been nearly parallel to a line passing through the first and last of those places, or in a direction N. 27° E. (true); which accords well with the observations at most of the individual stations, and particularly with the *vanishing direction* in Professor Kelland's remarkable observation at Granton.

“ 2. The Durham observation is compatible with the above-mentioned group within the limits of error. By the combination of Durham and Edinburgh (the base line perpendicular to the assumed direction of the meteor's motion being 95 miles), I calculated that the meteor passed vertically nearly over the Island of St Kilda, with an absolute elevation of about 88 miles. But this solution seems absolutely excluded by observations at Glasgow which admit of no question, and which I have spared no pains in verifying. Had the position of the meteor been such as I have first assumed, it could not possibly have been seen over even the roofs of the houses from the station occupied by Mr Stevenson, much less over the chimneys. The bearing, at the moment of explosion at Glasgow, also singularly enough corroborates sufficiently well the comparatively small elevation (about 20 miles above the earth) which the combination of Edinburgh and Glasgow gives; and this bearing we have seen to have been also accurately defined by the physical obstacles bounding the observer's view; it would have given a parallax of 15° , subtended by the perpendicular on the meteor's path, referred to Glasgow and Edinburgh respectively. Now, if this calculation were anything like correct, the Perth observation is entirely wrong; and the meteor could not have risen about 6° above the horizon of Durham, instead of 10° or 11° as estimated. I am unable, in any degree, to explain these conflicting results.

“ 3. The observations of Professor Kelland at Granton, and those at Perth, through the great azimuths of 125° and 130° , described by the meteor with such remarkable deliberation of motion, lead, when analyzed, to the very same results which presented themselves to the

mind of the spectator intuitively ; namely, that the motion must have been sensibly rectilinear, equable, and parallel to the horizon at Edinburgh. Assuming that the greatest altitude at Edinburgh was 15° , and the bearing then N. 63° W. (true), we may calculate that the altitude should have been on this hypothesis, when first seen by Professor Kelland, $11^{\circ} 47'$,—instead of 12° as observed ; at explosion, $6^{\circ} 59'$ (7° observed), and at its final disappearance $0^{\circ} 47'$ (instead of $0^{\circ} 30'$ observed). Again, at Perth the observed altitude, when first seen, was $3\frac{1}{2}^{\circ}$, and the calculated altitude $5^{\circ} 3'$, taking the maximum altitude at $17\frac{1}{2}^{\circ}$. The coincidence is, on the whole, remarkable, though it would be rash to push it to an extreme, as an error of some degrees may exist in the assumption of the direction of the meteor's course. Some later observations, received from Mr Curtis at Longford, and a consideration of the effects of perspective at Perth and Edinburgh, incline me to admit that the path might make an angle 3° or 4° greater with the meridian than I have above supposed. These conclusions are independent of the actual distance or parallax of the meteor ; which, as I have said, cannot be determined without further observations, which I should be glad to receive from any quarter, but more particularly from Ireland, and from the centre and NW. of Scotland. If correct, they entitle us to infer that the meteor in question was most probably a body moving in space, in a path little curved, and not revolving round the earth."

3. Notes on the Purification and Properties of Chloroform.

By William Gregory, M.D., Professor of Chemistry in the University.*

1. Chloroform has been prepared both from alcohol and from wood-spirit. The latter has been used for the sake of cheapness ; but as it is a mixture of several liquids, all of which do not yield chloroform, it gives an impure product, in a proportion which varies much, but is always below that obtained from alcohol. There is

* Although I am alone responsible for the opinions contained in this paper, it is my duty to state, that all the experiments and observations mentioned in it have been made by me in concert with my able assistant, Mr Alexander Kemp, of whose ingenuity and accuracy I have had constant opportunities of judging.