result, but also the difference between the greatest and least means taken, or the limits within which all the measures necessarily lie.

The stars themselves are arranged in order of right ascension for convenience of reference. After the statement of the mean results of the several sets of observations both of angle and distance, a final mean with a mean date for an epoch is deduced. In the case of Sir William Herschel's stars, a comparison of the measures now obtained with those given in his catalogues, or now for the first time brought to light by a careful examination of his manuscripts, is subjoined. By this comparison several fresh instances have been found of double stars, in which the relative motion of the individuals composing them is satisfactorily proved. In one remarkable case (that of the star δ Equulei,) this change has gone to an enormous extent, and is satisfactorily referred to proper motion in the large star. In another not less singular, all the three stars of a triple star (ζ Cancri) are ascertained to be relatively in motion, describing orbits about each other, and forming probably a ternary system by the mutual gravitation of its members, thus completely justifying the views taken by Sir William Herschel of this subject, in his papers published in the Transactions of this Society in 1802 and 1804.

Annexed, as an appendix to these observations, is a re-examination of about 27 stars measured in the former paper already alluded to, and which were considered as presenting peculiar interest, from the evidence then obtained of their relative motion and of their connexion in binary systems. The results of this re-examination are in the highest degree satisfactory, as, with only two or three exceptions, these stars have been found to continue their motions in the directions, and in the greater number of cases with nearly the velocities, predicted. In the most remarkable case, that of the double star ξ Ursæ Majoris, an angle of nearly 14° has thus been described by the two stars about their common centre of gravity in an interval of less than two years, thus affording every probability that in a very few years we shall arrive at a perfect knowledge of the figure, elements, and position of their orbits, and be enabled by strict calculation to answer the important question, whether the Newtonian law of attraction is confined to our own system or obtains also in the sidereal heavens.

An Account of the Construction and Adjustment of the New Standards of Weights and Measures of the United Kingdom of Great Britain and Ireland. By Captain Henry Kater, *F.R.S.* Read November 24, 1825. [*Phil. Trans.* 1826, Part II. *p.* 1.]

The author, after stating that the weights and measures of the United Kingdom are founded on a standard whose length is determined by its proportion to that of a pendulum vibrating mean time in London, which has been ascertained by him to be 39·13929 inches of Sir George Shuckburgh's scale, considers it necessary, on account of the importance of the result, to consider what degree of confidence

it is entitled to. For this purpose it is necessary to compare this final result with those obtained in other experiments and by different methods. Now it appears that previous to the experiments detailed in the author's paper on the subject in the Philosophical Transactions for 1818, on which this result rests, another series is there mentioned, made with the same instruments, but under circumstances which occasioned their rejection, and which, owing to some repairs in the instruments between the two series, which occasioned a material alteration in the distance between the knife edges, have all the weight of experiments made with a different pendulum; the result of these rejected experiments, however, differed only two ten-thousandths of an inch from that ultimately adopted.

The author next compares the length of the seconds pendulum at Unst and at Leith Fort, as ascertained by him by an invariable pendulum, whose vibrations had previously been determined in London, and whose length was thus known in terms of the London Seconds Pendulum, and as ascertained by M. Biot at the same stations, by means of a variety of pendulums, and by a totally different method of observation,—that of Borda. The results of this comparison are a difference between the determinations of M. Biot and the author, of 0·00029 inch in excess at the former station, and 0·00015 in defect at the latter.

From this near agreement of all the results, he considers that the length of the seconds pendulum in London, may be regarded as certainly known to within one ten-thousandth of an inch; while from the near agreement of the results of the French and English experiments on the length of the pendulum, he concludes that the length of the metre in parts of Sir George Shuckburgh's scale, may also be regarded as known within one ten-thousandth of an inch.

From an account recently published by Captain Sabine of his valuable experiments for the determination of the variations in length of the seconds pendulum, he observes, doubts may be inferred of the accuracy of the method employed by him for the observations for determining the length of the seconds pendulum in London, as well as in those which have been made with the invariable pendulum. It is asserted there, that taking a mean between the disappearances and re-appearances of the disc, is a more correct method of observation than than pursued by Captain Kater, and that the intervals between the coincidences obtained, by observing the disappearances only of the disc, would be productive of error.

In answer to this objection the author remarks, 1st, That with respect to the convertible pendulum, or that used for determining the absolute length of the seconds pendulum, the disc was made to subtend precisely the same angle as the tail-piece of the pendulum, so that at the moment of disappearance its centre necessarily coincided precisely with the middle of the tail-piece, and the difference between the moments of disappearance and re-appearance is rigorously nothing, an adjustment indispensable in his method of observing, when the object is to determine the true number of vibrations in 24 hours.

2ndly. With the invariable pendulum, the disc subtended a somewhat less angle than the tail-piece, so that the inferred number of vibrations in 24 hours was diminished about $\frac{2}{10}$ths of a second. But experiments with the invariable pendulum being intended to be in the strictest sense of the word comparative, this constant difference will no way affect the ultimate result. But as the most direct way to remove any doubts which may be entertained on the subject, the author has computed from the whole of Captain Sabine's observations, the successive differences in the vibrations at the various stations visited by him, by the two methods, viz. that of employing the disappearances and re-appearances, and the disappearances alone. The results only in one instance differ so much as a tenth part of a vibration. They are indifferently in excess and defect, and the mean of their discrepancies is exactly nothing. From this he concludes, that if the observations be made as nearly as possible under similar circumstances, the method of observing by disappearances alone is productive of no perceptible error in practice, in experiments with the invariable pendulum, while in those with the convertible pendulum the equal apparent size of the disc and tail-piece precludes the possibility of any, either in practice or theory, from this cause.

The standard of Sir George Shuckburgh having been found identical with that of Bird, in the custody of the clerk of the House of Commons, adopted as the imperial standard unit of extension, the length of the pendulum already determined is fixed with the same degree of precision in parts of the Imperial standard yard.

A repetition of Sir George Shuckburgh's experiments on the weight of given volumes of distilled water, and a re-measurement of the cube, sphere, and cylinder used by him, were found to give no material variation from his results; and these being stated in terms of the mean of several standard weights kept at the House of Commons, the troy pound nearest the mean has been adopted and declared by the legislature to be the original unit of weight under the denomination of the Imperial standard troy pound.

The relation between this pound and the cubic inch of distilled water at 62° Fahrenheit, barometer 30 inches, has been ascertained by the Commissioners of Weights and Measures, who find that the latter contains 252,458 grains, each grain being the 5760 part of the standard troy pound.

The avoirdupois pound is fixed for assigning its proportion to the standard troy pound, so as to contain exactly 7000 such grains.

The Imperial standard gallon is defined by stating its contents under the same circumstances of temperature and pressure at 10 pounds avoirdupois; and the bushel, by its containing 80 such pounds.

The author having, in compliance with a request of the Lords Commissioners of His Majesty's Treasury, undertaken to superintend the construction of, and to adjust the principal standards to be deposited at the Exchequer, Guildhall, Dublin, and Edinburgh, Mr. Dollond was directed to prepare those of linear measure, and Mr. Bate those of weight and measure, the proper quality of metal for

the latter purpose being determined by experiments instituted for the purpose.

The experiments for adjusting them are then given in full detail. The troy pounds were first adjusted, and the exactness with which this operation has been performed may be appreciated from this,—that the final errors of none of them exceed $\frac{2}{1000}$ths of a grain. When brought so near, it was of course not thought necessary to attempt further correction.

The avoirdupois pounds and the weights of the gallon of water were then derived from the troy pounds, and finally adjusted like them by inclosing within the weight, in hollows left for the purpose, wires equal to the errors ascertained to exist in them; the weights of these wires in each case is stated; so that should they by any accident be taken out and lost, they may be restored.

He next describes the method used in adjusting the gallon itself, the method of filling it exactly and of weighing it when filled, together with the corrections depending on the circumstances of temperature and pressure under which the experiments were made. As a final result, it appears that one only of the gallons was ultimately found in error to a greater extent than $\frac{6}{10}$ths of a grain, the others having their errors less than a fourth of that quantity.

The quarts and pints being next disposed of, the author describes the balance contrived by him for weighing the bushels, which proved so delicate as to turn with a single grain when loaded with 250 pounds in each scale. The resulting bushels when finally adjusted, were found to have all their apparent errors less than 6·56 grains of water, while the corrections for temperature and pressure only amounted in some cases to no less than 138 grains; but this depending on the figure of the glass used to cover them, it is not to be understood that the contents of the vessels have actually been ascertained to this degree of precision.

The adjustment of the standard yards is next described; and the author concludes his paper by a summary of the results arrived at in the present inquiry respecting British weights and measures. The length, he remarks, of the pendulum vibrating seconds in London has been found in parts of the Imperial standard yard; so that the value of the yard may at any time be known, having been referred to a natural standard presumed unalterable. The length of the French metre, a standard expressing a certain portion of the terrestrial meridian, has also been given in parts of the English scale. The weight of a cubic inch of distilled water has been determined in parts of the Imperial troy pound, and thus the pound if lost may at any future time be recovered. The avoirdupois pound is now for the first time defined, and the measures of capacity are made to depend on the weight of water they contain; the Imperial gallon containing ten pounds avoirdupois of water, having been declared to be the unit or only standard measure of capacity, from which all others are to be derived. This, it is presumed, will tend powerfully to produce uniformity throughout the United Kingdom, by putting

it in the power of every individual possessed of standard weights to verify his measures of capacity with the utmost facility.

Description of an improved Hygrometer. *By Mr.* Thomas Jones. *Communicated by Captain* Henry Kater, *F.R.S.* Read June 16, 1825. [*Phil. Trans.* 1826, Part II. *p.* 53.]

The principle of Mr. Jones's Hygrometer is essentially the same with that of Mr. Daniell's, or rather with that employed by Mr. Dalton to determine the quantity of aqueous vapour present in the air, viz. to ascertain the temperature at which dew is deposited from the atmosphere. It differs from Mr. Daniell's, however, in the frigorific action being applied *immediately* to the bulb of the thermometer employed to measure the temperature.

This bulb is of a considerable size, and of a cylindrical form, slightly flattened, and extended at the end. The stem of the thermometer being twice bent at right angles, this end of the bulb turns upwards. It is made of black glass and is exposed, but the rest of the bulb is covered with muslin. This being moistened with ether, the mercury is cooled, and dew at length settles on the exposed part, at which moment it is read off.

Mr. Jones, after describing this instrument, obviates an objection to its use, drawn from the application of the frigorific process to the *lower* part of the bulb, while the dew is deposited at the upper. This objection, if valid, might be obviated, by inclining the bulb so as to have its axis horizontal. But repeated trials have satisfied him of there being no occasion for this precaution.

Mr. Jones finally alludes to the use of a similar construction in Vienna.

Observations on the Changes which have taken place in some ancient Alloys of Copper. *By* John Davy, *M.D. F.R.S.* *In a Letter to Sir* Humphry Davy, *Bart. P.R.S.* Read November 17, 1825. [*Phil. Trans.* 1826, Part II. *p.* 55.]

Dr. Davy first describes the nature of an incrustation upon an ancient helmet found in a shallow part of the sea, between the citadel of Corfu and the village of Castrades. The surface was of a variegated colour, mottled with spots of green, dirty white, and red. The red and green patches exhibited minute crystals of red oxide of copper, and metallic copper; and were further composed of its green submuriate and carbonate. The dirty white parts consisted chiefly of oxide of tin. These new combinations are only superficially produced; the metal was found bright beneath, and consisted of copper alloyed with 18·5 parts of tin.

An ancient nail from a tomb in Ithaca, and a mirror from a tomb at Samos, in Cephalonia, afforded nearly similar but less distinctly crystalline results. The copper in the mirror was alloyed with 6 per cent. of tin, and a minute portion of arsenic.