accurate estimate of any of the charges has not been obtained owing to the difficulties of experimenting with the clouds. As no trustworthy [1] independent estimates have been made of n, the value of the product $n \times e$ for gaseous ions can only be obtained by this method within wide limits differing by a factor of 10 or 20. It cannot, therefore, be maintained that the direct determination of e in gases leads to any trustworthy information as to the simple relations that hold between the charges on the ions.

A more accurate comparison of the charges on the various kinds of ions can be obtained from determinations of the rate of diffusion of ions in gases and the velocity under an electric force. With this object in view, the rates of diffusion produced by various methods in gases were determined, and it was shown that the value of $n \times e$ for negative ions in gases agreed within 10 per cent. or 15 per cent. with the value for monovalent ions in liquids, and the value for positive ions in gases was somewhat larger (J. S. Townsend, "Diffusion of Ions in Gases," Phil. Trans., vol. cxciii., 1899, and vol. cxcv., 1900). The probable error in the numbers obtained is about 10 per cent. or 12 per cent., so that it is desirable to know more definitely if all these charges are exact multiples of the same atomic quantity, as it is a question of fundamental importance.

The problem of the determination of $n \times e$ for gases has been again undertaken, and a simple experiment has been devised whereby the exact value of $n \times e$ can be immediately deduced from the ratio of the charges acquired by two conductors under special conditions. The method is explained in a paper in the Proceedings of the Royal Society, vol. lxxx., January, 1908, and two papers recently communicated (November, 1908) contain further experiments by the present writer on ions produced by Röntgen rays, and an investigation by Mr. Haselfoot of the ions produced by radio-active substances.

The principle of the method consists in finding the extent to which a uniform stream of ions having a circular cross-sectional area, S, opens out as the ions travel a given distance under a known electromotive force. For this purpose three plates, A, B, and C, are arranged parallel to each other, the middle plate, B, and the lower plate, C, having each a circular aperture cut through its centre. A disc, D, is fixed in the aperture of the plate C, so that the surfaces of the disc and surrounding plate are in the same plane, the disc being a little smaller than aperture in order to insulate it from the plate. The area of the hole S in the middle plate B is equal to the area of the disc *plus* half the air-gap between the disc and the plate C. The plates A and B are connected to suitable numbers of accumulators so as to maintain the same uniform field above and below the middle plate B. The plate C and disc D are insulated, and each maintained at zero potential by a special form of induction balance, which gives the charges acquired simultaneously by the disc D and plate C. The gas in the space between A and B is ionised by Röntgen rays or by radio-active substances, and a uniform stream of ions passes through the aperture in the middle plate. The ions travel to the lower plate under the uniform electric field, and the stream opens out by diffusion, so that some of the ions q_1 arrive on the disc D, and the rest q_2 arrive on the plate C. The ratio q_1/q_2 is found accurately by means of the induction balance, and the value of $n \times e$ may be obtained from the ratio. The equation connecting $n \times e$ and the ratio n_1/n_2 is somewhat complicated, and it would be impossible to explain in a short space how the connection between these quantities is found, but it may be stated that a complete solution of the problem can be obtained in a series of Bessel's functions.

The experiments have been made with different forces and pressures, and it has been found that the value of $n \times e$ for negative ions is in all cases within 3 per cent. or 4 per cent. of the value $1{\cdot}23 \times 10^{10}$; under conditions where the greatest accuracy can be obtained the results are in closer agreement with this number.

For positive ions the value of $n \times e$ depends on the nature of the radiation. With non-penetrating secondary rays from a polished metal surface the value obtained was $1{\cdot}26 \times 10^{10}$, and for penetrating rays from a tarnished surface, or a surface covered with a thin layer of vaseline, larger values were obtained, the greatest being $2{\cdot}4 \times 10^{10}$.

Thus the negative ions have always a charge which is exactly equal to the charge on a monovalent ion in a liquid electrolyte, and the positive ions have either a single or a double charge, the number of either kind in a conducting gas depending on the nature of the radiation.

The values of $n \times e$ for positive and negative ions produced by the α and β rays from radio-active substances are both approximately $1{\cdot}23 \times 10^{10}$.

In addition to the above results, a notable effect of small traces of moisture on the motion of negative ions was observed. When the gas is very dry the negative ions move as if they were very small particles, but when a small amount of moisture is admitted the mass of the negative ion is greatly increased, and obeys the same laws of diffusion as the positive ions. The motion of the positive ions under similar conditions is not affected by the dryness of the gas.

JOHN S. TOWNSEND.

[1] Prof. Perrin has recently announced a new method of determining n, which gives trustworthy results. The number n comes to 3×10^{19} and corresponds to an atomic charge $4{\cdot}1 \times 10^{-10}$. (Jean Perrin, *Comptes rendus*, October 5, 1908).

METEOROLOGICAL CHARTS OF THE INDIAN OCEAN.[1]

THE Indian Ocean is claiming at the present time a large share of the attention of meteorological offices. Recent issues of NATURE have contained notices of meteorological charts for this area issued by the Meteorological Department of the Government of India and by the Meteorological Institute of the Netherlands (NATURE, vol. lxxviii., pp. 169, 487). The present charts are prepared by the Deutsche Seewarte. In area they exceed considerably those referred to above, for they embrace the region between latitudes 30° N. and 50° S., and longitudes 18° E. (Cape Town) and 158° E. The Australian waters and the eastern margin of the Pacific Ocean are thus included, while special inset charts extend the area northwards to include the Yellow Sea and the Sea of Japan. To deal effectively with the results, a scale of approximately 6 mm. to one degree at the equator has been selected, and in consequence an inconveniently large size of page, viz. 36 inches by 27 inches, has had to be adopted.

The preparation of the results has occupied five years. The meteorological information has been abstracted mainly from the log-books of German vessels, but we are glad to note that, in addition, use has been made of all available published information. The arrangement of the data on the charts, of which there is one for each month, is similar to that adopted on the charts for the Atlantic Ocean issued by the Seewarte. Conspicuous blue wind roses show for each square of 5° the percentage frequency of calms and of winds from each of sixteen directions. The mean wind force for each direction, on the Beaufort scale, is indicated by the number of barbs on the wind arrows. Small but distinct black arrows give the directions of surface currents, with the average and the maximum observed displacement in nautical miles per day. Special attention has been devoted to a critical examination of the current data, and several interesting articles on the subject appear on the backs of the charts. A statement of the number of observations on which each wind and current arrow is based would have been welcomed by students.

In addition, each chart gives the tracks for steam and sailing vessels, the normal paths of hurricanes, the frequency of fog and ice, and the lines of equal magnetic declination. The region of easterly variation is distinguished by a special tint. The text printed over the land areas gives, in addition to the necessary explanations, a brief summary of the weather conditions of each month, with special reference to the frequency of hurricanes.

On the back of each chart we find four smaller maps, giving the annual change of magnetic variation, the average air temperature over sea and land, the average temperature of the surface water, and the average barometric pressure. In connection with the latter, we miss

[1] Deutsche Seewarte, Monatskarten für den indischen Ozean. (Hamburg Eckardt und Messtorff, n.d.)

an account of the diurnal variation of pressure, which is so important in the tropics. The only reference to this phenomenon is contained, incidentally, in an article on rules for handling the ship in hurricanes, given on the back of the chart for December.

The remaining space on the backs of the charts is utilised to the full. On several of them detailed information is given of the systems of storm signals used in the area covered by the charts. Others give particulars of the time-signal stations. Numerous fully illustrated articles give particulars of meteorological events of special interest, such as the Hong Kong typhoon of September 18, 1906, and other famous hurricanes. In addition, we have a number of monographs on all manner of subjects of interest to the sailor and the meteorologist. Among them we mention specially one on the prevalence of easterly winds to the south of latitude 50° S.

We congratulate the Seewarte on the completion of so important and arduous a piece of work, which is sure to prove of the utmost value both to sailors and students.

THE FILTRATION AND PURIFICATION OF WATER FOR PUBLIC SUPPLY.[1]

GREAT progress has been made in recent times in the appliances for purifying water. It is no longer necessary to go to distant uplands for a pure and palatable supply. By the methods of treating ordinary river water, carrying possibly hundreds of objectionable germs per c.c., drinking water is now being prepared from the lower reaches of the Thames and of many Continental rivers as wholesome as can be obtained from the mountains of Wales or of Scotland. So great has been the activity of scientific workers in this field that a new and complex branch of technology may be said to have come into existence.

With reference to sources of supply, water companies should not place too much reliance on the innocuousness of supplies drawn from country districts. Water-courses and reservoirs should be protected from the intrusion of harmful matters, and the adjacent ground should be fenced off and planted. Special precautions are needful for preventing the ingress of impurities to wells and bore-holes, and where pollution occurs the origin of the same may be detected by suitable experiments. Storage reservoirs are a useful adjunct to a purifying plant, even when not required for conserving the supply, and it has been proved by the researches of Dr. Houston that the bacteria of enteric practically all disappear from impounded water in two or three days. Still, as it appears that even here the survival of the fittest holds good, and that a few germs live on for weeks, water undertakers are not relieved from the duty of further treating the supply. Sedimentation proceeds more or less rapidly in stagnant reservoirs, but it has been found at the Paris installations that effective precipitation can be secured by running the water in channels, with frequent changes of direction. Thus space is economised.

Discussing the retention of bacteria in filter beds, the lecturer directed particular attention to the functions of the filtering skin. It appears that in the finishing filter at Bedford, which is fed by a sprinkler, no skin is formed at the surface, because the water does not rest there. It sinks at once into the sand, and at a depth of about an inch and a half a slimy growth is easily perceptible on the grains, and this possibly serves the same purpose as the network of algoid growths bedecking the open sand beds. There are five distinct ways in which the sand bed operates in eliminating impurities, but what is most important in the operation of these beds is the circumstance that, after cleaning, a considerable time must elapse before the purifying agencies come into effective action. Water managers should have the means of finding out when the effluent is pure, and in order to do this they must rely on bacteriological analyses. This is the method adopted on the Continent. Unfortunately, it is generally neglected here, and it is a matter of chance in too many cases whether there may or may not be dangerous germs passing through. Chemical analyses alone cannot reveal whether the filtrate is wholesome or not. The amount of nitrogen present as nitrate and nitrite is important enough, but analysts should not rely on this as the chief criterion for determining the purity of a sample.

[1] Abstract of a paper by Mr. John Don selected by the Council of the Institution of Mechanical Engineers for the first award of the "Water Arbitration Prize," 1908, and read before the Institution on January 15.

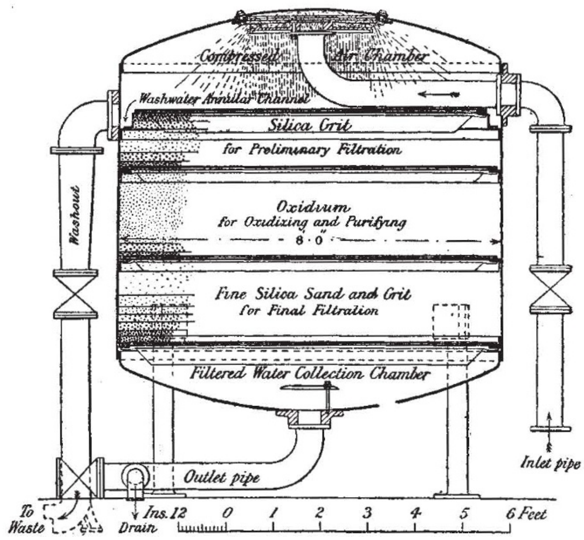

FIG. 1.—Compressed Air and Oxidising Waterworks Filter (Candy).

Recently many mechanical appliances have been brought into use for the purification of water, and among these the Jewell filter is largely used in America. A precipitate of sulphate of alumina forms an efficient skin within a short time after cleaning, and thus there is a great saving of time. The water also passes through the filtering layers forty times more quickly than it does in the open sand filter, but the effluent, subjected to every test, proves to be of a high degree of purity. In Britain, Mather and Platt's and Bell's filters are of similar construction, and

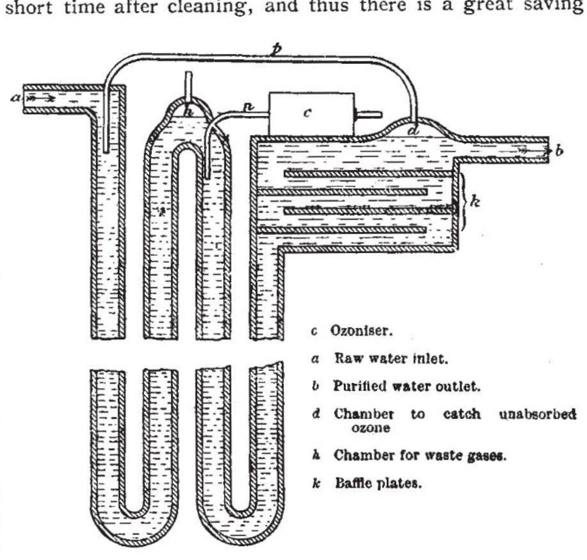

FIG. 2.—Sketch of Ozonising Apparatus (Howard-Bridge) Scale about $\frac{1}{32}$. Action of the Apparatus:—As the raw water passes down the pipe *a* it draws the unabsorbed ozone by way of the tube *p* from the chamber *d*. Freshly ozonised air is also drawn into the current from the ozoniser through the pipe *n*. After traversing the vertical pipes, the water is caused to pass round a series of baffle plates *k*, and finally flowing under the recess at *d* it reaches the outlet.