the contraction which ensues on diluting an aqueous solution proceeds continuously, and the molecular volume of a salt in solutions of different strengths is continuously greater the larger the amount of salt present. So that in none of these thermal or volumetric phenomena is any discontinuity observed, or any indication of the formation of compounds of definite composition, distinguishable by characteristic properties.

The question we are now considering, as to whether in a solution the solvent and the substance dissolved in it—or any portion thereof—exist independently of each other, is in some degree answered by the facts known as to the specific heats and vapour-pressures. For instance, when water is added to a solution of sodium nitrate, the molecular heat of the resulting liquid seems to show that all the water added is influenced at least until a very large quantity is present. In this case one molecule of sodium nitrate can affect the movements of a hundred molecules of water, and probably more. It is also well known that the vapour-pressures of water holding in solution almost any dissolved solid is less than the vapour-pressure of pure water, and that the boiling-point of a liquid is raised by the addition to it of any soluble non-volatile substance. This fact of reduction of pressure can only be explained upon the hypothesis that there is no free water present at all; that is, that there is no water present which is not more or less under the influence of the dissolved substance.

What becomes of water of crystallisation forms a part of the same question as to the relation of solvent to solvent. Observed facts lead us to conclude that white copper sulphate, blue anhydrous cobalt chloride—and, by analogy, other salts which are colourless—retain their hold upon water of crystallisation when they are dissolved in water. A very important observation has been made by Dr. Nicol which bears directly upon this question. In his study of the molecular volumes of salt solutions he finds that, when a salt containing water of crystallisation is dissolved, this water is indistinguishable by its volume from the rest of the water of the solution. In the report presented to the British Association last year, the following passage occurs: "These results point to the presence in solution of what may be termed the anhydrous salt in contradistinction to the view that a hydrate, definite or indefinite results from solution; or in other words, no part of the water in a solution is in a position relatively to the salt different from the remainder."

These two statements, however, are not strictly consequent upon each other. The view seems preferable that (save, perhaps, in excessively dilute solutions) the dissolved substance is attached in some mysterious way—it matters not whether it be supposed to be chemical or physical—to the *whole* of the water. We cannot otherwise get over the difficulty presented by the hydrated salts, which give coloured solutions, by the control of the vapour-pressure of the dissolved salt, and by the altered specific heat. With regard to water of crystallisation, E. Wiedemann has shown that hydrated salts in general expand enormously at the melting-point; and the observations of Thorpe and Watts on the specific volume of water of crystallisation in the sulphates of the so-called magnesium group show that, whilst the constitutional water occupies less space than the remaining molecules, each successive additional molecule occupies a gradually increasing volume. So that when a salt, with its water of crystallisation, passes into the liquid state (either by melting or by solution in water), it requires a very slight relaxation of the bonds which hold the water to the salt for it to acquire the full volume of liquid water, whilst the water of constitution is not so easily released. And this conclusion accords with Nicol's observations on the molecular volumes of the salts when in solution.

Now comes the question as to what determines the solubility of a substance. Why, for example, is magnesium sulphate very soluble in water, whilst barium sulphate is almost totally insoluble? With regard to salts the following propositions seem to be true:—(1) Nearly all salts which contain water of crystallisation are soluble in water, and for the most part are easily soluble; (2) insoluble salts are almost always destitute of water of crystallisation and rarely contain the elements of water; (3) in a series of salts containing nearly allied metals the solubility, and capacity for uniting with water of crystallisation generally, diminish as the atomic weight increases.

The fusibility of a substance has also much to do with its solubility. Neither fusibility alone nor chemical constitution alone seems to be sufficient to determine whether a solid shall be soluble or not. But it may be taken as a rule to which there are no exceptions that when there is a close connection in chemical constitution between a liquid and a solid, and the solid is at the same time easily fusible, it will also be easily soluble in that liquid.

Salts containing water of crystallisation may be considered as closely resembling water itself, and these are for the most part both easily fusible and easily soluble in water. But space is wanting for the discussion of the details of these matters, as well as of the relation of molecular volume to fusibility of solids.

The fascinating character of the phenomena of supersaturation has attracted a host of experimenters, but no definite explanation has been generally accepted. In the opinion of the speaker supersaturation is identical with superfusion. Supersaturated solution of, say, alum, thiosulphate of sodium melted in its water of crystallisation, and fused sulphur at 100°, exhibit phenomena of exactly the same kind.

Finally, we are led to the consideration of what is meant by chemical combination. From the phenomena under discussion, and others, the conclusion seems inevitable that chemical combination is not to be distinguished by any absolute criterion from mere physical or mechanical aggregation; and it will probably turn out ultimately that chemical combination differs from mechanical combination, called cohesion or adhesion, chiefly in the fact that the atoms or molecules of the bodies concerned come relatively closer together, and the consequent loss of energy is greater.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Of the students in Natural Science entered at Cambridge this term no fewer than 116 have already announced their intention of studying medicine.

DUBLIN.—The Senate of the Royal University has conferred the degree of Doctor of Science *honoris causâ* upon James Bell, Ph.D., F.R.S., Principal of the Somerset House Laboratory.

SCIENTIFIC SERIALS

Revue d'Anthropologie, troisième série, tome 1, Paris, 1886.—On the Simian characters of the Naulette jaw, by M. Topinard. This celebrated find, which was discovered at the bottom of an obscure cavern 25 m. below the present level of the Lesse, near Dinant, in Belgium, is chiefly remarkable for its excessive prognathism, which is due alike to the great thickness of the horizontal branch of the jaw when compared with its height, and to the special obliquity of the axis of the alveolus of the second molar. In its relative proportions the Naulette jaw must be characterised not only as non-human, but as plus-Simian. A careful comparison of the Naulette jaw with the maxillary processes of the anthropoids, and of several of the lowest extant human races, has led M. Topinard to the conclusion that in the age of the mammoth, tichorine rhinoceros, and cave-bear, there had already appeared numerous mixed human types, to one of the lowest of which it may be presumed that the Naulette jaw belonged.—On the population of Bambouk, on the Niger, by Dr. Colin. An interesting paper on an extensive, but very imperfectly-known, region of Western Soudan, exclusively inhabited by a branch of the great Manding race, known as the Mali-nkès. The Bambouk territories, more than 600 kilometres in length, and from 80 to 150 in width, are divided into numerous little States, most of which enjoy a complete autonomy. Their want of consolidation, and the indifference of the people to all forms of religion, have made the Mali-nkès objects of contempt to their Mussulman black neighbours, but according to the narrations of the Griotes, or itinerant bards, who are to be met with in every part of Western Africa, they had at one time extended their dominion over all the tribes on the right banks of the Niger, and were preparing to invade Saigon when the advance of the French forced them to fall back within their original limits. For a time they submitted to the restrictions of Mohammedanism, but now they appear to have absolutely no religion. They prepare an intoxicating drink from honey, called "dolo," in which women as well as men indulge to excess. The men are indolent, hunting only to avert starvation, and working their exten-

sive gold-mines imperfectly, and chiefly by the help of the women, to whom falls the chief share of providing for the wants of the community, but who, after marriage, enjoy great freedom, although the young girls are kept under strict supervision.—On the human bones found in France in caverns belonging to the Quaternary age, by M. Cartailhac. Of such finds, none can be referred to the early period of the Saint Acheul, or Chelles deposits, the oldest belonging apparently to the Mousterian age, while the most abundant human remains are found in the comparatively recent beds of Solutré and La Madelaine. The former of these are remarkable for the enormous number of horse-bones accumulated about the stone hearths and in the kitchen-middens of this station. According to Dr. Cartailhac, 40,000 skeletons might be reconstructed from these equine remains, which seem to have been exposed to the action of fire, the greater number of the bones having been broken for the extraction of the marrow, whence he assumes that the horse must have reached its maximum development and served in the place of all other game at the period of the Solutré deposits. The writer compares together the human and other remains found in various Mediterranean and inland caves, with the special object of ascertaining how far the condition and mode of deposition of the skeletons can throw light on the vexed question whether the great preponderance of fractured over whole bones in these primæval graves indicates the practice of cannibalism, or whether it may not be dependent on the observance of special modes of burial, involving the burning or dismemberment of the body after death.—The facial angle proposed by Cuvier and Geoffroy Saint-Hilaire for comparative anatomical determinations and for measuring facial differences in the living subject, by Dr. Collignon. The writer, who considers at length the merits of the various angles proposed by Camper and others, concludes by showing the superiority, for practical purposes, of adopting Cuvier's facial angle, measured by Topinard's goniometer for determining the median angle.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 26.—M. Jurien de la Gravière, President, in the chair.—On the unequal flow of gases, by M. Haton de la Goupillière. In continuation of his recent communication on this subject the author here deals with the reverse problem of a receptacle originally filled with compressed air discharging itself freely into the atmosphere.—On the intensity of the magnetic field in dynamo-electric machines, by Marcel Deprez. Assuming that the most important element of a dynamo-electric machine, whether employed as a generator or receiver, is the magnetic field, the author deals with the influence of the deviation of the magnetic pieces, and shows that, contrary to the opinion of certain electricians, the intensity of the field decreases far less rapidly than the distance of the magnetic pieces increases. The influence of the dimensions perpendicular to the lines of force is also considered.—Researches on the decomposition of the bicarbonate of ammonia by water, and on the diffusion of its components through the atmosphere, by MM. Berthelot and André. From the experiments here described, the authors are led to the conclusion that it is the diffusion of the carbonic acid that determines the decomposition by water of the bicarbonate of ammonia, and consequently the transport of the ammonia itself. These results are of the greatest importance even for the purely physical study of the circulation of gases between the ground, the waters, and atmospheric air, apart altogether from the phenomena of vegetation.—Note accompanying the presentation of his work entitled "An Introduction to the Study of the Human Races," by M. de Quatrefages. This is the first volume of the "Bibliothèque d'Ethnologie," edited jointly by the author and M. Hamy. It contains a summary of the views expounded in greater or less detail in his other writings, while dealing more fully with a number of other matters, which he had hitherto merely indicated, or else entirely neglected for lack of the fresh data and discoveries which now enable him to discuss them seriously. One of the most important is the question of prehistoric man, and he now shows that even in Quaternary times the human race had already spread over the whole earth to the remotest extremities of the Old and New World. This ubiquity of Quaternary man already suggested the existence of the species in the previous epoch, and direct proofs of this fact have recently been multiplied to such an extent that the presence of man in Europe during Tertiary times may now be regarded as placed beyond reasonable doubt, although his presence in America is not yet established. The results yielded by palæontology, geology, and even history point to the extreme north of Asia as the cradle of the human race and the centre of dispersion, which had already begun in Tertiary times. Here also were differentiated the three fundamental types, to which all races may still be reduced, as well as the three linguistic types diffused throughout the globe. It is further shown that hypsistenocephaly is the main feature distinguishing the American from the European primitive race, and that the man of Canstadt, hitherto regarded as the oldest Quaternary type, in reality dates back to the Tertiary epoch.—Note on the meteorite which fell on January 27, 1886, at Nammianthul, in the Presidency of Madras, by M. Daubrée. This meteorite, a specimen of which has been received from Mr. Medlicott, of the Indian Geological Survey, presents the ordinary characters of the group of small sporadic asters.—Experiments on the transmission of force by means of a series of dynamo-electric machines coupled together, by M. Hippolyte Fontaine. These important experiments (carried out with seven Gramme machines, under the inspection of the Commissioners, MM. Bertrand, Becquerel, Cornu, Maurice Lévy, Marcel Deprez, and Mascart) show that it is possible to transmit an effective force of fifty horse-power through a resistance of 100 ohms at a loss of less than 50 per cent.—On algebraic surfaces capable of a double infinity of birational transformations, by M. E. Picard. In supplement to his previous communication on algebraic surfaces, the author here shows that, for all surfaces capable of a double infinity of birational transformation, the co-ordinates of any given point are expressed by the uniform (Abelian) functions of two parameters.—On the transformation of surfaces in themselves, by M. H. Poincaré. It is shown in connection with M. Picard's theorem that, in certain cases, the Abelian functions may degenerate into triply periodical, elliptical, or even rational functions.—Extension of Riemann-Roch's theorem to algebraic surfaces, by MM. Noether.—On the recomposition of white light by means of the colours of the spectrum, by M. Stroumbo. A process is described by means of which the recomposition of white light is effected, taking as the starting-point the very colours of the spectrum, and utilising, as in Newton's experiment with the disk, the persistence of the images on the retina.—Note on the principal showers of shooting-stars and the aurora borealis, by M. Ch. V. Zenger. A careful study of M. Rubenson's great Catalogue of the Auroras from 1800 to 1877 has unexpectedly revealed the fact that August 10 and November 14 show a great frequency of these lights, thus coinciding with the periods of the shooting-stars and suggesting a connection between these two orders of phenomena.—Influence of the amplitude of the lunar oscillation in declination on the shiftings of the northern trade-winds, by M. A. Poincaré. A study of the tables for 1880-83 shows certain relations between these phenomena, which, however, differ greatly according to the seasons.—On the phenomena associated with the heating and cooling of molten steel, by M. Osmond. It is shown that, as the quantity of carbon is increased, the temperature of transformation of the iron is lowered, and that of recalescence raised, so that both coincide in the hard steel.—Saturation of normal arsenic acid by the water of baryta, by Ch. Blarez.—On the function of the semicircular canals of the inner ear, by M. Yves Delage. The chief function of this apparatus, as already recognised by Goltz, Flourens, and others, is shown to be distinct from that of the auditory sense, and connected rather with the rotatory movements of the head, either alone or with the body.—On Syndesmis, a new type of Turbellariæ described by W. A. Sillimann, by M. Ph. François. This organism is shown to be, not an ectoparasite of the large green nematoid, as supposed by Sillimann, but a true endoparasite of *Strg. lividus*.—On two Synascidians new to the French sea-board (*Diazona hebridica*, Forbes and Goodsir, and *Distaplia rosea*, Della Valle), by M. A. Giard.—Organisation of *Lepidomenia hystrix*, a new type of Solenogaster, by MM. Marion and Kowalevsky.—On the Gephyrians belonging to the family of the Priapulidæ collected by the Cape Horn Mission, by M. Jules de Guerne. The discovery of these organisms is a remarkable instance of the presence in the southern seas of forms almost identical with those of the Arctic Ocean.—The simple epidermis of plants considered as a reservoir of water, by M. J. Vesque.—Remarks on *Poroxylon stephanense*, by MM. C. Eg. Bertrand and R. Renault.—On