

March 5, 1891.

Sir WILLIAM THOMSON, D.C.L., LL.D., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

In pursuance of the Statutes, the names of the Candidates for election into the Society were read from the Chair, as follows:—

Anderson, William, M.Inst.C.E.	Gilchrist, Percy C.
Bateson, William, M.A.	Gotch, Francis, M.R.C.S.
Beddard, Frank Evers, M.A.	Halliburton, William Dobinson, M.D.
Beevor, Charles Edward, M.D.	Harcourt, Professor Leveson Francis Vernon, M.Inst.C.E.
Blake, Rev. John Frederick, F.G.S.	Heath, Christopher, F.R.C.S.
Boulenger, George Albert.	Heaviside, Oliver.
Bower, Professor Frederick Orpen, D.Sc.	Herdman, Professor William Abbott, D.Sc.
Buzzard, Thomas, M.D.	Hickson, Sydney John, D.Sc.
Cheyne, Professor William Watson, F.R.C.S.	Howorth, Henry Hoyle.
Conroy, Sir John, Bart., M.A.	Joly, John, M.A.
Crisp, Frank, LL.B.	Jones, Professor John Viriamu, M.A.
Cunningham, Professor Daniel John, M.D.	Kidston, Robert, F.G.S.
Davis, James William, F.G.S.	King, George.
Dawson, George Mercer, D.Sc.	Lansdell, Rev. Henry, D.D.
Dibdin, William J., F.C.S.	Larmor, Joseph, D.Sc.
Dickinson, William Howship, M.D.	Lydekker, Richard, B.A.
Dreschfeld, Professor Julius, M.D.	Macalister, Donald, M.D.
Eaton, Rev. Alfred Edwin, M.A.	McConnell, James Frederick Parry, Surgeon - Major, F.R.C.P.
Edgeworth, Professor Francis Ysidro, M.A.	MacMunn, Charles, M.D.
Elliott, Edwin Bailey, M.A.	Marr, John Edward, M.A.
Ellis, William, F.R.A.S.	Matthey, Edward, F.C.S.
Foster, Professor Clement Le Neve, D.Sc.	Mond, Ludwig, F.C.S.
Frankland, Professor Percy Faraday, B.Sc.	Newton, Edwin Tully, F.G.S.
Gadow, Hans, M.A.	Nicholson, Professor Henry Alleyne, M.D.
	Ord, William Miller, M.D.

Pedler, Professor Alexander, F.C.S.	Thompson, Professor Silvanus Phillips, D.Sc.
Reade, Thomas Mellard, F.G.S.	Thomson, Professor John Millar, F.C.S.
Roberts, Ralph A., M.A.	Thornycroft, John Isaac, M. Inst. C.E.
Rutley, Frank, F.G.S.	Tizard, Thomas Henry, Staff- Commander R.N.
Seebohm, Henry, F.L.S.	Take, Daniel Hack, M.D.
Shaw, William Napier, M.A.	Veley, Victor Hubert, M.A.
Sherrington, Charles Scott, M.B.	Waller, Augustus D., M.D.
Stebbing, Rev. Thomas Roscoe Rede, M.A.	Woodward, Horace Bolingbroke, F.G.S.
Stevenson, Thomas, M.D.	Young, Professor Sydney, D.Sc.
Stewart, John Heron Maxwell Shaw, Major-General R.E.	

The following Papers were read :—

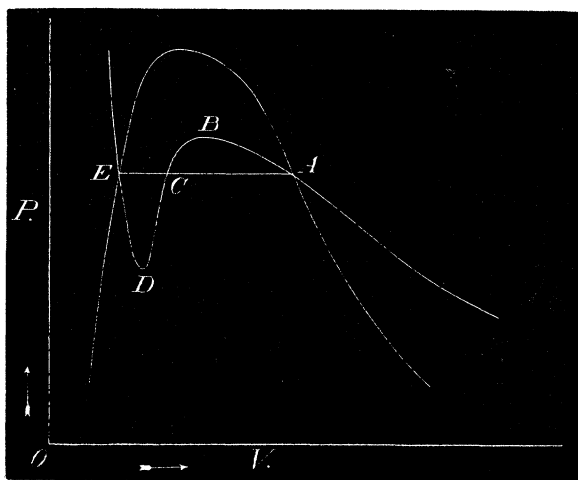
I. "Some Suggestions regarding Solutions." By WILLIAM RAMSAY, Ph.D., F.R.S., Professor of Chemistry in University College, London. Received February 16, 1891.

The brilliant presidential address of Professor Orme Masson at the Chemical Section of the Australasian Association for the Advancement of Science marks a distinct advance in our ideas of solution. The analogy between the behaviour of a liquid and its vapour in presence of each other and of a pair of solvents capable of mutual solution is so striking as to carry conviction. The resemblance of the liquid-vapour curve, with its apex at the critical point, to the solubility curve, with its apex at the critical solution point, appears to me to prove beyond cavil that the two phenomena are essentially of the same nature. The address will take rank along with van't Hoff's classical paper on "Osmotic Pressure."

There are two other phenomena, which, it appears to me, are made clear by the ideas of Professor Masson. The first of these has reference to supersaturated solutions. The curves (published in 'Nature,' vol. 43, p. 348, Feb. 12, 1891) showing the analogy between liquid-gas and solution curves, are isobaric curves, or, more correctly, they represent the terminations of isobaric curves in the region of mixtures, where, on the one hand, a liquid exists in presence of its vapour, and, on the other, one solvent in presence of another (for both solvents play the part of dissolved substances as well as of solvents). M. Alexéeff's data are not sufficient to permit of the construction of a curve representing a similar region mapped out by the termination of isothermal lines. But it is obvious that it

would be possible to determine osmotic pressures of various mixtures by the freezing-point method, and so to construct isothermal curves for such mixtures of solvents. And there can be no reasonable doubt that, as the isobaric curves of liquid-gas and of solvent-solvent display so close an analogy, the isothermal curves would also closely resemble each other.

Granting then that this is the case, we may construct an imaginary isothermal curve on the model of the curve for alcohol published in the 'Phil. Trans.' by Dr. Sydney Young and myself. Now, in one series of papers on the liquid-gas relations, we showed that with constant volume pressure is a linear function of temperature; and we were thus able to calculate approximately the pressures and volumes for any isothermal representing the continuous transition from the gaseous to the liquid state (see 'Phil. Mag.,' 1887, vol. 23, p. 435). It would be interesting to ascertain whether, if concentration be kept constant, osmotic pressure would also show itself to be a linear function of temperature. But, this apart, it appears in the highest degree probable that there should also exist, in theory, at least, a continuous transition from solvent to solvent, the representation of which would be a continuous curve. In such a case, on increasing the concentration of the solution by eliminating one solvent, the other solvent should not separate visibly, but the two should remain mixed, until one solvent has been entirely removed.



The accompanying diagram will make this clear. The sinuous curve ABCDE may represent either continuous change from gas to liquid along an isothermal on decrease of volume, or it may

represent a similar continuous change from saturated solution to dissolved substance on increase of concentration.

Mr. Aitken's experiments on the cooling of air containing water-vapour have shown us that it is possible to realise a portion of the curve AB; the phenomenon of "boiling with bumping" constitutes a practical realisation of a portion of the curve DE; and we may profitably inquire what conditions determine such unstable states with solvent and solvent.

Regarding the portion of the curve AB, I think that no reasonable doubt can be entertained. It precisely corresponds to the condition of supersaturation. In the liquid-gas curve, the volume is decreased at constant temperature without separation of liquid; in the solvent-solvent curve the concentration is increased without separation of the solvents. Dr. Nicol has shown that it is possible to dissolve dry sodium sulphate in a saturated solution of sodium sulphate to a very considerable extent without inducing crystallisation; and here we have a realisation of the unstable portion of the curve AB. In the gas-liquid curve pressure falls with formation of a shower of drops; in the solvent-solvent curve crystallisation ensues, and the solvents separate. The phenomena are, however, not completely analogous; the complete analogy would be if the temperature were so low that the substance in the liquid-gas couple were to separate in the solid, not in the liquid, state. This, so far as I am aware, has not been experimentally realised, but one sees no reason why it should not be possible.

I have some hesitation in offering speculations as to the state of matter at the portion of the continuous curve DE. It may be that it corresponds to a syrupy or viscous state. Cane-sugar at a moderate temperature dissolves water; indeed it is possible to obtain a solution of 1 per cent. of water in molten cane-sugar. And such a solution, if quickly cooled, remains a syrup. But it can be induced to crystallise by the presence of crystals. Thus, in such a mixture of sugar and water, a few grains of crystalline sugar cause the whole mass to crystallise, and water saturated with sugar and sugar separate into two layers. Here, again, a complete analogy fails us, for it is a solid which separates. As we know nothing of the osmotic pressure of a syrup, the analogy is a defective one; but it is probable that a dilute solution of sugar would pass continuously into a syrup of pure sugar by evaporation of the solvent, and analogy would lead to the supposition that the syrup coincides with the unstable state of the liquid. I would, therefore, offer the analogy between the syrupy and the supercooled states as a tentative one; it lacks foundation in both cases.

One point remains to be mentioned. I have for the past nine months, in conjunction with Mr. Edgar Perman, been determining

the adiabatic relations for liquid and gaseous ether: the rise of pressure and temperature when volume is decreased without escape of heat. It is obvious that similar relations are determinable for solutions, and probably with much greater facility. M. Alexéeff has made some measurements which might be utilised for this purpose; but they are far too few in number, and, moreover, the necessary data as regards osmotic pressure are wholly wanting. It would be possible by a series of differential experiments to ascertain the evolution of heat on increasing concentration, and so to arrive at a knowledge of the specific heats of the solution at constant osmotic pressure, corresponding to the idea of specific heat at constant pressure; and also of specific heats at constant concentration, corresponding to specific heats at constant volume. I do not know whether such researches would yield as accurate results as those we are at present carrying out, but they are at least well worthy of attention.

II. "Preliminary Notice of a New Form of Excretory Organs in an Oligochætous Annelid." By FRANK E. BEDDARD, M.A.,
Prosector of the Zoological Society. Communicated by
Professor E. RAY LANKESTER, M.A., LL.D., F.R.S.
Received February 19, 1891.

So far as our knowledge of the Oligochæta goes at present, the excretory system appears to consist either of one or more pairs of separate nephridia in each segment, or of a diffuse, irregularly arranged system of tubules with numerous external pores upon each segment, and often with numerous coelomic funnels in each segment; there may or may not be a connexion between the tubes of successive segments. All the aquatic Oligochæta have nephridia of the first kind; a large number of the terrestrial Oligochæta have nephridia of the second kind; there is occasionally in the latter forms a specialisation of part of the diffuse nephridial system into a pair of large nephridia; these species connect the two extremes. But in all these Worms the nephridia are contained in the coelom, though some of the connecting branches may be retroperitoneal; the ducts which lead to the exterior may branch in the thickness of the body wall, but there does not seem to be any extensive ramification and anastomosis of the tubes in the muscular layers of the body wall.*

I have recently found a remarkably different arrangement of the nephridia in an Annelid belonging to a new genus of Eudrilidæ. This family is chiefly noteworthy on account of the remarkable modi-

* 'Quart. Journ. Micr. Sci.,' vol. 28, Pl. xxx, fig. 1, *n*, and fig. 2.

