near Altoona, and in New Jersey on the seashore. In the latter location the animal had availed itself of the building-material at hand by forming the foundation of its watch-tower of little quartz pebbles, sometimes producing a structure of considerable beauty. In this sandy site the tube is preserved intact by a delicate secretion of silk, to which the particles of sand adhere. This secretion scarcely presents the character of a web-lining, but has sufficient consistency to hold aloft a frail cylinder of sand when it is carefully freed from its surroundings. A nest recently obtained from Vineland, N.J., furnished an interesting illustration of the power of these araneids to intelligently adapt themselves to varying surroundings, and to take advantage of circumstances with which they certainly could not have been previously familiar. In order to preserve the nest with a view to study the life-history of its occupant, the sod containing the tube had been carefully dug up, and the upper and lower openings plugged with cotton. Upon the arrival of the nest in Philadelphia, the plug guarding the entrance had been removed; but the other had been forgotten, and allowed to remain. The spider, which still inhabited the tube, immediately began removing the cotton at the lower portion, and cast some of it out. Guided, however, apparently by its sense of touch, to the knowledge that the soft fibres of the cotton would be an excellent material with which to line the tube, she speedily began putting it to that use, and had soon spread a soft smooth layer over the inner surface and around the opening. The nest in this condition was exhibited, and showed the interior to be padded for about four inches from the summit of the tower. The very manifest inference was drawn, that the spider must for the first time have come in contact with such a material as cotton, and had immediately utilized its new experience by substituting the soft fibre for the ordinary silken lining, or by adding it thereto.

LETTERS TO THE EDITOR.

Equations of third degree.

THE second or third terms of any equation may be made to disappear, and we may therefore assume

$$x^3 + Ax^2 + B = 0; \qquad (1)$$

and the solution of this equation must involve the general solution of cubics. Assume

$$x = y^{\frac{2}{3}} - y^{\frac{1}{3}}z^{\frac{1}{3}} + z^{\frac{2}{3}}. \qquad (2)$$

Hence

$$y^{\frac{1}{3}} = \sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{1}{2}z^{\frac{1}{3}}.$$

$$y = \sqrt[\frac{3}{2}]{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{3}{2}xz^{\frac{1}{3}} - z + \tfrac{3}{4}z^{\frac{2}{3}}\sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}}.$$

$$y + z - \tfrac{3}{2}xz^{\frac{1}{3}} = \sqrt[\frac{3}{2}]{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{3}{4}z^{\frac{2}{3}}\sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}}.$$

$$z^{\frac{2}{3}} - \frac{y+z}{x}z^{\frac{1}{3}} = \frac{x^3 - (y+z)^2}{3x^2}.$$

$$z^{\frac{1}{3}} = \sqrt{\frac{4x^3 - (y+z)^2}{12x^2}} + \frac{y+z}{2x}.$$

$$z = \sqrt[\frac{3}{2}]{\frac{4x^3 - (y+z)^2}{12x^2}} + \frac{y+z}{2} + \frac{3(y+z)^2}{4x^2}\sqrt{\frac{4x^3 - (y+z)^2}{12x^2}}.$$

$$432x^6(z-y)^2 =$$
$$64x^9 + 240x^6(y+z)^2 + 192x^3(y+z)^4 - 64(y+z)^6.$$

$$x^9 - 3x^6(y+z)^2 + 3x^3(y+z)^4 - (y+z)^6 = -27zyx^6.$$

$$x^3 + 3\sqrt[3]{zy}\,x^2 - (y+z)^2 = 0. \qquad (3)$$

In (1) and (3), equating coefficients,

$$3\sqrt[3]{zy} = A, \quad zy = \frac{A^3}{27}. \qquad (4)$$

$$-(y+z)^2 = B, \quad y^2 + 2yz + z^2 = -B. \qquad (5)$$

Whence, from (4) and (5),

$$y = \sqrt{-\frac{B}{4}} + \sqrt{-\frac{B}{4} - \frac{A^3}{27}}.$$

$$z = \sqrt{-\frac{B}{4}} - \sqrt{-\frac{B}{4} - \frac{A^3}{27}}.$$

Substituting these values of y and z in (2),

$$x = \sqrt[\frac{2}{3}]{\sqrt{-\frac{B}{4}} + \sqrt{-\frac{B}{4} - \frac{A^3}{27}}} - \frac{A}{3} + \sqrt[\frac{2}{3}]{\sqrt{-\frac{B}{4}} - \sqrt{-\frac{B}{4} - \frac{A^3}{27}}}, \qquad \text{formula } (a)$$

or

$$x = -\sqrt[3]{\frac{B}{2} + \frac{A^3}{27} - \sqrt{\frac{B^2}{4} + \frac{A^3B}{27}}} - \frac{A}{3} - \sqrt[3]{\frac{B}{2} + \frac{A^3}{27} + \sqrt{\frac{B^2}{4} + \frac{A^3B}{27}}}. \qquad \text{formula } (b)$$

In the case of the irreducible case of formula (*b*), which is similar to Cardan's formula, formula (*a*) may be used. In such case, only one part, as $\sqrt{-\frac{B}{4}}$, of formula (*a*) is imaginary, and $\sqrt{-\frac{B}{4} - \frac{A^3}{27}}$ is real; and if the signs of the roots of equation (1) be changed, which is done by changing simultaneously the signs of A and B in equation (1), the converse is true, that is, $\sqrt{-\frac{B}{4}}$ is real, and $\sqrt{-\frac{B}{4} - \frac{A^3}{27}}$ is imaginary. Which shall be the imaginary term is, then, arbitrarily chosen. Hence, factoring preparatory to expansion by the binomial theorem, the coefficient of $\sqrt{-1}$ may be made less than unity when the real term is unity. A. M. SAWIN.

Evansville, Wis.

Solar constant.

It is feared that the letter of Mr. Hazen (SCIENCE, i. 542) in relation to above topic may not entirely remove the confusion of which he justly complains. It should be premised that there are two units of heat in common use among physicists: the smaller being the quantity of heat required to raise the temperature of one gram of water 1° C.; the larger, the quantity of heat required to raise the temperature of one kilogram of water 1° C. The larger of these units is a thousand times as great as the smaller; and, in ordinary applications, no confusion is liable to arise. In either case, the number of units of heat received by the unit-mass of water is (sensibly) proportional to the number of degrees of rise of temperature.

With regard to the 'solar constant,' two additional units are required, — a unit of surface, and a unit of time. This constant may be defined in general terms to be the number of units of sun-heat incident perpendicularly on a unit-surface, in a unit of time, at the upper limit of the earth's atmosphere; or it is the number of degrees Centigrade a unit-mass of water would be raised in temperature by the sun-heat incident perpendicularly on a unit-surface, in a unit of time, at the upper limit of the atmosphere. The three units here indicated are, of course, arbitrary. But most physicists, following the example of Pouillet (*Comptes rendus*, vii. 24), take the gram, square centimetre, and minute, as respectively the units of mass, surface, and time. With regard to time, there is no diversity, the minute being universally used; but, for mass and surface, some employ the larger units of a kilogram and a square metre, and hence the apparent confusion. To obtain a general expression for the value of the 'solar constant,' let

Q = Quantity of sun-heat incident normally on a unit-surface in a unit of time = solar constant.
S = Area of surface receiving the heat.
T = Time of receiving the heat.
m = Unit mass of water.
n = Number of unit masses of water heated.
t° = Rise in temperature of the mass of water.

Then we have

$$Q \times S \times T = n \times m \times t^\circ.$$

Consequently, when S, T, and n are severally equal to unity, we have $Q = m \times t^\circ$; and, when $m = 1$, $Q = t^\circ$ = rise in temperature of a unit-mass of water = value of solar constant in units of heat.

Now, when the unit of time remains the same, but the units of mass and surface are changed, the value of t° (which measures the solar constant) will be altered, unless both of these units are changed in the same ratio. For, from the equation $Q = m \times t^\circ$, it follows that t° varies as $\frac{Q}{m}$; but evidently Q is proportional to the magnitude of the unit of surface: hence t° varies as $\frac{\text{unit of surface}}{\text{unit of mass of water}}$.

For example: using Pouillet's units, Langley's recent experiments make the solar constant = 2.84; that is, the sun-heat incident normally on one square centimetre, in one minute, at the upper limit of the atmosphere, would raise the temperature of one gram of water 2.84° C., or would heat 2.84 grams of water 1° C. Now, the unit remaining the same, if we assume the unit of mass to be one kilogram (1,000 grams), and the unit of surface to be one square metre (10,000 square centimetres), we should have the value of the constant $t'^\circ = \frac{10,000}{1,000} \times 2.84 = 28.4$ kilogram-units of heat; that is, the sun-heat incident normally on one square metre, in one minute, at the upper limit of the atmosphere, would raise the temperature of one kilogram of water 28.4° C., or would heat 28.4 kilograms of water 1° C.

Moreover, as it requires a definite number of units of heat to liquefy a unit-mass of ice, or to evaporate a unit-mass of water, or to produce a unit of mechanical energy, it follows that this constant may be measured by either of these units.

The exact determination of the value of this constant is a most refined and difficult experimental problem; for it involves the precise estimation of the amount of solar heat absorbed in traversing the earth's atmosphere, or the law of extinction of sun-heat in passing through it: hence it is, that, although several excellent physical experimenters have attacked the problem, their results are not so accordant as would be desirable. The following are some of the results: —

Experimenter.	Date.	Solar constant.	
		Gram-units of heat per square centimetre per minute.	Kilogram-units of heat per square metre per minute.
Pouillet . .	1838	1.7633	17.633
Forbes . .	1842	2.847	28.47
Crova . . .	1876	2.323	23.23
Violle . . .	1876	2.540	25.40
Langley . .	1882	2.840	28.40

JOHN LECONTE.

Berkeley, Cal., June 25, 1883.

WARD'S DYNAMIC SOCIOLOGY.

Dynamic sociology, or applied social science, as based upon statical sociology and the less complex sciences. By LESTER F. WARD, A.M. 2 vols. New York, *Appleton*, 1883. 20+706; 7+690 p. 8°.

I.

THIS work of Mr. Ward is composed of two distinct parts. The first gives the outlines of his philosophy, as a basis for his reasoning in the one that follows. The second is a discussion of the causes and consequences of progress, or evolution, in human society. For some purposes it would have been wise to give each part a distinct title, reserving for the last part the one used; but the philosophic system propounded in the first part has evidently been prepared as a basis for the second, and in itself would not be considered by the author as a complete exhibit of his philosophy.

Vol. i. contains: first, an outline of the work, in which the author's purposes are clearly set forth; second, an historical review, chiefly devoted to a discussion of the philosophies of August Comte and Herbert Spencer; third, the cosmic principles underlying social phenomena, in which the outlines of the new system are set forth. Under the general title of 'primary aggregation,' he discusses the constitution of celestial bodies and chemical relations. Under that of 'secondary aggregation,' he discusses biology, psychology, and the genesis of man. Under that of 'tertiary aggregation,' he discusses the genesis of society and the characteristics of social organization. The purpose of this preliminary volume on general philosophy, and of the introduction to the second volume, is tersely given by Mr Ward himself, as follows: —

"The purpose of the present chapter [chap. viii.], as already announced, has been to accomplish the complete orientation of