will venture to do so. If, therefore, life exists in other parts of this great universe, does it necessarily occupy bodies of protoplasm in those different, remote spheres? It would be a great assumption. It is altogether improbable. The certainty is, that in those planets which are in proximity to the sun's heat there could be no protoplasm. Protoplasm in the remote planets would be a hard mineral, and near the sun it would be dissipated into its component gases. So that, if life be found in other parts of this universe, it must reside in some different kind of material. It is extremely probable that the physical conditions that reside in protoplasm might be found in other kinds of matter. It is in its chemical inertness, and in its physical constitution, that its adaptation to life resides; and the physical constitution necessary for the sustentation of life may be well supposed to exist in matter in other parts of the universe. I only say the door is open, and not closed: any one who asserts that life cannot exist in any other material basis than protoplasm is assuming more than the world of science will permit him to assume. And that it is confined to this single planet, and not in the great systems of the universe, — that assumption will not for a moment be allowed. Therefore the subject is one which allows us a free field for future investigation: it is by no means closed in the most important laws which it presents to the rational thinker. I hope, therefore, that, if the evidence in favor of this hypothesis of the creation of living forms be regarded as true, that no one will find in it any ground for any very serious modification of existing ideas on the great questions of right and wrong which have long since been known by men as a result of ordinary experience, and without any scientific demonstration whatsoever.

A classification of the natural sciences.[1]

BY T. STERRY HUNT, LL.D., F.R.S., OF MONTREAL.

To frame a rational classification of the natural sciences, and to define their mutual relations, have often been attempted. The present writer, in an essay read before the National academy of sciences in April, 1881, and since published in the Philosophical magazine, with the title of 'The domain of physiology,' suggested the basis of such a scheme, and now, at the request of some of his readers, ventures, for the first time, to embody in a concise and tabulated form the views then and there enunciated, in the hope that other students may find it not unworthy of their notice.

The study of material nature constitutes what the older scholars correctly and comprehensively termed physics (the words 'physical' and 'natural' being synonymous), and presents itself in a twofold aspect, — first, as descriptive; and, second, as philosophical, — a distinction embodied in the terms 'natural history' and 'natural philosophy,' or, more concisely, in the words 'physiography' and 'physiology.' The latter word has been employed, in this general sense, to designate the philosophical study of nature from the time of Aristotle, and will so be used in the present classification.

The world of nature is divided into the inorganic or mineralogical, and the organic or biological, kingdoms; the division of the latter into vegetable and animal being a subordinate one. The natural history, or physiography, of the inorganic kingdom, takes cognizance of the sensible characters of chemical species, and gives us descriptive and systematic mineralogy, which have hitherto been restricted to native species, but, in their wider sense, include all artificial species as well. The study of native mineral species, their aggregations, and their arrangement as constituents of our planet, is the object of geognosy and physical geography. The physiography of other worlds gives rise to descriptive astronomy.

The natural philosophy of the inorganic kingdom, or mineral physiology, is concerned, in the first place, with what is generally called dynamics or physics; including the phenomena of ordinary motion, sound, temperature, radiant energy, electricity, and magnetism. Dynamics, in the abstract, regards matter in general, without relation to species; chemism generates therefrom mineralogical or so-called chemical species, which, theoretically, may be supposed to be formed from a single elemental substance, or *materia prima*, by the chemical process. Dynamics and chemistry build up our inorganic world, giving rise to geogeny, and, as applied to other worlds, to theoretical astronomy.

Proceeding next to the organic kingdom, its physiographical study leads us first to organography, and then to descriptive and systematic botany and zoölogy, two great subdivisions of natural history. Coming, then, to consider the physiological aspect of organic nature, we find, besides the dynamical and chemical activities manifested in the mineral, other and higher ones which characterize the organic kingdom. On this higher plane of existence, are found portions of matter which have become individualized, exhibit irritability, the power of growth by assimilation, and of reproduction, and which establish relations with the external world by the development of organs, all of which characters are foreign to the mineral kingdom. These new activities are often designated as vital; but since this word is generally made to include at the same time other manifestations which are simply dynamical or chemical, I have elsewhere proposed for the activities characteristic of the organism the term biotics (βιοτικός, pertaining to life). The physiology of matter in the abstract is dynamical, that of mineral species is both dynamical and chemical, while that of organized forms is at once dynamical, chemical, and biotical. All of these, I may remark, I regard as successive manifestations of an energy inherent in matter.

The study of the biotical activities of matter leads to organogeny and morphology, while the relations of organisms to one another and to the inorganic kingdom give us physiological botany and zoölogy. We thus arrive at a comprehensive and simple scheme of the natural sciences, which I have endeavored to set forth in the subjoined table.

[1] Abstract of paper read in general session, Aug. 17, 1883.

Natural Sciences;	Inorganic Nature;	Organic Nature.
Descriptive. General Physiography, or Natural History.	Mineral Physiography. Descriptive and Systematic Mineralogy; Geognosy; Geography; Descriptive Astronomy.	Biophysiography. Organography; Descriptive and Systematic Botany and Zoölogy.
Philosophical. General Physiology, or Natural Philosophy.	Mineral Physiology. *Dynamics* or *Physics;* *Chemistry.* Geogeny; Theoretical Astronomy.	Biophysiology. *Biotics.* Organogeny; Morphology; Physiological Botany and Zoölogy.

PROCEEDINGS OF SECTION A. — MATHEMATICS AND ASTRONOMY.

PAPERS READ BEFORE SECTION A.

[*Continued.*]

Orbit of the great comet of 1882.

BY EDGAR FRISBIE OF WASHINGTON, D.C.

This is a partial record of observations at Washington. Mr. Winlock is preparing a description of all the physical phenomena of the comet which were there observed. The first Washington observation of the comet was at two o'clock on a September afternoon, and a comparison was then made with the position of the sun. Good observations were obtained on the meridian for three days. The calculations from these served to fix the place of the comet with fair approximate accuracy for three months, which was a somewhat remarkable success. Afterward a difficulty occurred in obtaining accurate observations; because there were several different points of light presented in an ill-defined nucleus, and it was uncertain whether the observations always referred to the same luminous point. These observations were made in October and November. The following ephemeris was calculated: —

Sept.	17.2282			ϕ	89° 13′ 42.70″
Ω	346°	1′	7.91″	log. a	1.9331366
π Ω	69	36	12.79	log. q	7.8904739
i	141	59	52.16	period	793.689

The author compared the foregoing with the observations of other astronomers. The most prominent variation was in respect to the period, which others gave as 659, 997, 852, and 654 years. A contrivance was exhibited, showing the respective positions of the earth and comet, and their directions of motion, by means of pasteboard planes attached at an angle.

The rotation of domes.

BY G. W. HOUGH OF CHICAGO, ILL.

Observatory domes are in general very heavy. As they grow old, owing to the settling of walls and other changes, they are apt to become almost unmanageable. The dome at Chicago is very weighty, every thing about the observatory being built in a very substantial manner. When Dr. Hough first tried to move the dome, he found its two sides working with unequal friction; and this was afterward remedied to some extent, but by no means fully. About two months ago a gas-engine was placed in position to revolve the dome. It was a great satisfaction to see the dome go round continuously, without hitches. The cost of moving the dome by such means is a mere trifle, aside from the first cost of the engine. The use of water-power where that was easily accessible must, however, be preferred in many instances where a sufficient head is supplied by street mains.

Dr. C. A. Young said, in discussing the foregoing, that when he came to Princeton he found a very heavy dome there. One man, using thirty pounds pressure on a two-foot crank, was very tired after giving the dome one turn. A gas-engine has since been put in below, and the power is communicated by a belt. A revolution can be made in four minutes, and the shutter raised in two. In general, the dome is placed and the shutter opened within five minutes. Dr. Young expressed a hope that the Brush storage batteries would furnish electrical illumination and power for the work of observatories, as the electricity might be stored even from a gas-engine operating a dynamo during hours of the day when there was no other use for its power. At present the direct action of a gas-engine on a dynamo, with no intervention between the dynamo and the light, was too irregular to serve the purpose.

Descriptive-geometrical treatment of surfaces of the second degree.

BY J. BURKITT WEBB OF ITHACA, N.Y.

For the purpose of greater conciseness the speaker confined his remarks to the general ellipsoid, remarking that the usual treatment of problems upon this surface — as, for instance, such problems as finding the shade and shadow, or drawing tangent planes — is lacking in generality; the body being taken in such