CHEMICAL HISTORY
OF THE
SIX DAYS OF CREATION.

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EDITOR OF THE "TECHNOLOGIST."

"Through faith we understand that the worlds were framed by the Word of God; so that the things which are seen were not made of things which do appear."

—HEBREWS IX:3.

"For if things be not as they are told in any relation, that relation must be false. And if false in part, we cannot trust it either in whole or in part."

—LESLIE'S *"Short and Easy Method with Deists."*

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In Memoriam.

Sarah Phin,

Teacher,

MELROSE, SCOTLAND.

"Favor is deceitful and beauty is vain, but a woman that feareth the Lord she shall be praised."

PREFACE.

What has a worker amongst furnaces, crucibles and retorts to do with a theological subject? Much, every way; not only on the broad ground that it concerns humanity, but also because it is in the results which are to be obtained only in the laboratory, that we must look for a clue to guide us through much of the darkness which surrounds the history of the earliest periods of creation.

The numerous attempts which have been made to reconcile the Mosaic cosmogony with that indicated by modern science, testify to the deep interest which most thinking men feel in the subject. The first chapter of Genesis has engaged the earnest efforts of the ablest and most learned of our orthodox divines, and it has called forth the hostility of the most bitter enemies of revelation. Alike in the covert attack of the author of the "Mosaic Cosmogony" in the "Essays and Reviews," and in the coarser* infidelity of Nott and Gliddon, the position is taken that the Mosaic account is "not an authentic utterance of Divine knowledge, but a human utterance." [And to-day the battle is waged as fiercely as ever. Dr. Schaff, in his preface to the recent and extensive commentary of Lange, states explicitly that "no other book of the Bible stands more in need of an exhaustive commentary just at this time. No one is so much exposed to the attacks of modern science in its temporary conflict with revealed truth. We say *temporary* conflict, for there can be no *essential* or *ultimate* discord between science and religion, philosophy and theology. The God of reason and the God of revelation is one and the same, and canuot contradict Himself. The difficulty lies only in our imperfect knowledge and comprehension of the book of nature, or of the Bible, or of both."]

* We characterize the infidelity of Nott and Gliddon as "coarse," becauee it is wanting in that liberality which leads all rightly-conetituted minds to accord a full measure of courteey to those who differ from them. Thie country ie supposed to be Christian, and in it there are many to whom the Bible ie dear. What then are we to think of a writer whoee want of decency ie such as to allow him to perpetrate the following parody of a well-known nursery rhyme:

"*The real question, however, posited in logical shape, is this:—The Hebrew Moses wrote the Hebrew Pentateuch. Did the Hebrew Moses write the Hebrew Pentateuch? If the Hebrew Moses wrote the Hebrew Pentateuch, where is the Hebrew Pentateuch the Hebrew Moses wrote?*"—TYPES OF MANKIND, p. 625.

In suggesting the points of harmony between science and revelation that are set forth in the following pages, the author would not be supposed to assume that we have reached the ultimate results either of scientific research or of biblical exegesis. But so far as the present light of science goes, we have endeavored to give a correct statement of facts; and the theory suggested certainly accords so wonderfully with the Mosaic account that it is at least impossible to say that in this matter science is in the slightest degree opposed to revelation.

We at first proposed to content ourselves with merely stating what we believe to be the scientific record, as developed by the application of chemical and physical principles, since the accordance which exists between this record and that given by Moses is too strict and too obvious to require that we should point it out. But we confess that as we proceeded in our work, the temptation to depart from this intention has frequently proved too strong for us.

The matter of the following little brochure has been delivered several times in nearly its present form, as a course of three lectures, in Western New York, during the winter of 1866–7. In substance, however, these lectures were delivered in the City of Rochester, N. Y., during the early part of the year 1862.

HAVANA, N. Y., 1868.

POSTSCRIPT.

"Times change, and we change with them." The following little work was written at the dates above given, but has lain unpublished until the present time. Since the manuscript was in reality completed, other works have been published, the most noticeable of which is Lange's Commentary, to which has been prefixed a very able dissertation by Prof. Taylor Lewis. On looking over our little brochure in the light of these more ponderous tomes, we find a wonderful similarity between many of the ideas, and even expressions contained in the two. It may be well, therefore, to state that with the exception of an interpolation in the preface (marked with brackets), and the first part of Chapter I., the MS. was sent to the printer precisely as it was copied from the rough draft, which was written by the author in the beginning of 1868.

NEW YORK, 1870.

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CHAPTER I.

Creation.

A full consideration of this subject does not come within the scope of the chemist's investigations. With the *origin* of gold or iron he has nothing to do; the physical properties of these bodies are all that concern him and these throw no light upon questions relating to the source or origin of their being. After the first creative act has been effected; after gold, iron, oxygen, sulphur, carbon and the other elements have come into existence, chemistry has everything to do with the changes which they undergo and produce, and with their influence on the growth and development of the world of which they form a part. But beyond this point chemical investigation cannot go. It is true that physical science does point to a beginning; and it is equally certain that the doctrine of the eternity of matter does not receive much support from chemistry and physics. But in regard to all these points science has nothing definite to offer. At the same time, however, there are certain subjects upon which modern science throws a good deal of light, even though it cannot be said to solve them. Thus there has long been a dispute as to the character of the creation mentioned in the first verse of Genesis. Some have regarded the first verse as a sort of announcement of the calling of matter into existence out of nothing, while the second and subsequent verses give an account of that which may have occurred millions of years after the

first creation. Upon this view the earth is supposed to have existed for long ages in its present form, peopled with the strange beings revealed by modern geology, and enjoying light and an alternation of night and day, that maintained a living flora and fauna on its surface. Those who adopt this theory believe that at the close of this period the earth was violently convulsed; the internal fires, let loose by volcanic action, came in contact with the waters of the ocean, and produced vast volumes of steam and carbonic and sulphurous acids. These dense vapors not only encircled the earth and produced total darkness on its surface; they also destroyed all animal and vegetable life, and the earth became, in the words of the text, *tohu* and *bohu*, "without form, and void," waste and desolate. The clearing away of these vapors was the re-ordaining of light and the creation of the firmament; while in the subsequent verses are described the re-ordering and re-peopling of our planet. To a certain extent such an hypothesis affords a fair explanation of the text; but there are in it certain deficiencies which must prove fatal objections. The most prominent of these are well stated by Prof. Lewis in the following passage taken from his "Special Introduction to the First Chapter of Genesis," prefixed to the American edition of Lange's Commentary:

"Another question arises. Was all the creation that Moses intends to describe *intra sex dies*, *within* six days, or was that part mentioned in the first verse *extra dies*, as it must be if the six days chronologically began in the evening —that is in the tohu and bohu, or when darkness was upon the face of the deep? But such exclusion would seem to be in the face of the express declaration in the fourth commandment: "In six days (within six days) God created the heavens and the earth." If, then, there was anything *extra dies*, or before the chronological beginning of the first

day, which is so distinctly marked by its evening, it could not be intended here as part of *this account*, for from the time God began this creative work (whatever it might include) until He rested in the evening after the sixth, there were six days, be they long or short, and no more. The reasoning is plain. The six days began with the evening of the tohu, followed by the ראמר, or command for the shining of the light, which was the first act in the formation of the heavens and the earth afterwards described. If, then, the first verse denotes a beginning before this, it must have been extra *sex dies*. If we would bring it within, then it must be regarded as a caption to the whole account, or as a summary of the process afterward in detail set forth. If it is without, then what is meant by the heavens and the earth (especially the earth) therein mentioned? Or it might be asked (and it would be very difficult to answer the question), What part of the first day? or how are we to get any part of the first day or first night between the ברא (created) of the first verse and the תרתה (moved) of the second?"

The hypothesis which we have just detailed is usually adopted by those who are anxious to find grounds for accepting six days of twenty-four hours each as the period of time that comprised the work described in the second and subsequent verses. If, however, we adopt the twenty-four hour theory, and consider the fearful velocity with which the waters must have moved on the third day, and the extraordinary convulsions which must have accompanied the work of the second day, we shall find that we must accept a condition of things as inexplicable, upon natural principles, as any system involving a mere series of creative fiats. We must remember, however, that the problem is not to discover how God *might* have done this thing, but to determine how He *did* do it. All ways would have been alike easy to Him.

But it is the province of science, as far as it has just data, to roll back the history of this planet, to unfold the long roll of the ages, and to discover the method and laws according to which the process of creation was carried out. In attempting this we shall hope to be able to demonstrate that no *expedients* are necessary in order to reconcile the simple account given by Moses with the scheme that is unfolded by science.

But although we cannot see any grounds for supposing that the first verses and those that follow do not relate to one and the same creation, it is unquestionable that some of our ablest commentators have found philological intimations that the account there given relates, not to the creation of the universe, but to *a* creation or *some* creation ; in other words, to that creation with which we are more immediately concerned.

That this is not improbable every scientific man will readily allow. Our planet is not the only planet, and our sun is not the only sun found in the several systems to which they belong. And so there may be other stellar systems far beyond the range of our telescopes—systems from which no influence of any kind has as yet penetrated to us across the dark abyss which divides their bounds from ours. When we speak of the creation of our stellar system as the only creation, we exhibit a strange ignorance of the wondrous extent of space. In the stellar system to which we belong there are members so remote that thousands of years elapse before the light emitted by them is able to reach us, although it travels at the rate of 200,000 miles per second. So that perchance when we turn our eyes to the blue vault above us, we receive from many a tiny star light which was emitted when Adam walked the gardens of Paradise and communed with his God-given helpmeet. And yet, this vast distance,

when compared with the void that separates us from the next stellar system, may be but as a step—an insignificant dividing line.

One of the most sublime discoveries of modern times is the universality of gravitation. But this universality has been traced but to the nearest fixed star; and far beyond our stellar system there may exist stars to which gravitation does not extend. It has been surmised by modern science that all forms of force are mere modes of motion either of the grosser matter recognisable by our senses, or of a more subtile fluid or fluids which have as yet escaped detection. There are even good grounds for believing in the existence of several of these fluids, each one differing from the others in mobility. Thus we have succeeded in attaining a vacuum so perfect that electricity cannot pass through it, and it is generally believed that the space outside of our atmosphere —that is, the space between the earth and the sun—is so devoid of matter that even the subtile lightning flash cannot leap across it. But no vacuum yet attained can bar the passage of heat or light—much less of gravitation. It may not be impossible, however, that in that abyss which divides us from these distant creations of the Great Author of all, there may exist such a perfect vacuity that even gravitation cannot pass the great gulf. In this case, these distant creations would not affect or disturb our astronomical relations, and many such creations might exist, each perfectly distinct, and none interfering with the others. In the infinite expanse of space a stellar system occupies a less proportionate extent than does the mote in our atmosphere as it dances in the sunlight. Science favors the supposition that our earth and system is but one of the younger members of the great family which, as children of the Almighty Creator, occupy the universe. If this be so, how many creations may there not have been antecedent to ours?

We have already remarked that with the origin or creation (bringing into existence) of things science has nothing to do, for the simple reason that the subject lies beyond its scope and power. And so too in regard to the methods adopted by the Divine Creator, science is mute. We find man on the earth, but (as mere scientists) we know not whence he comes or whither he goes. Attempts have been made in recent times to solve this problem, and the development hypothesis has been propounded as a solution of the mystery. We must confess that however much we may dissent from some of the propositions put forth by those who have adopted this theory, we cannot share in that theological timidity which raises a fresh alarm at every new solution of these old questions. Atheism is not concealed in the hypothesis, but in the deductions which men draw from this hypothesis. It is not because of the facts with which he deals, but because of the folly of his heart that the atheist says "There is no God;" and we have good authority for saying that though you bray him and his false logic in the mortar of reason, among the wheat of facts, with the pestle of argument, yet will not his folly depart from him.* The nebular hypothesis and the development hypothesis may both be true, and God still remain the Creator of the universe. For He must be the author of the laws according to which the development in both cases proceeded; and we cannot see that His power and sovereignty are exhibited in a lesser degree in creation by law than in creation by fiat.

"Only let us keep to the old Hebrew modes of thinking and speaking," says the writer already quoted, "and we need not be afraid of naturalism. It is God's nature that we read of in Genesis. If life is said to come from the waters, let us remember that it was upon these same waters

*Proverbs xxvii:22.

the Spirit moved in the first mysterious night of creation. If it is naturalism, it is the naturalism of the Bible ; and the wonder is that such plain declarations of birth, growth, succession, law, generation—one thing coming out of another —should have been so much overlooked. It is because the Scripture doctrine of the Word, or Logos in nature has so fallen out of our theology, that we dread so much the appearance of naturalism. In proportion as we have lost that true scriptural idea of supernaturalism, which sees no inconsistency in such blendings, are we driven to the dogmatic or arbitrary supernaturalism to defend our religious ideas from the equally dogmatic and arbitrary naturalism of modern science.

"We have endeavored to be brief; but the reader is requested to compare the hints here given, with the unmistakable language of the scripture. Instantaneous creations there might have been, for anything our reason could say to the contrary ; but the actual creation in the Bible is set forth as a succession. It is a series of תלדות or generations, each one revealing those unseen things of God from which are made the things that do appear. The other mode would have been to us the revelation of a fact or facts alone. As we have it given unto us, it is a revelation of something more and higher—of law, of process,—of artistic beauty,—of architectural wisdom. It is not the *power* alone, but the very *mind* of God that is shown to us. The one would have been a creation simply in space ; God has seen fit to reveal to us a creation in *time* as well as in space, and this is inseparable from the ideas of succession, series, causation —in a word, of *nature*, beginning in the supernatural, yet having its law given to it, and capable of yielding obedience to that law." *

* Prof. Lewis' "Special Introduction to the First Chapter of Genesis."—Lange's Commentary, vol. 1, page 147.

And yet in the face of these sound conclusions by one of our most eminent commentators and theologians, it is too often true that when the scientific man presents theories whereby it is attempted to unveil the processes of creation, many good men are apt to recoil from that which appears to them little else than sacrilege; and they even go so far as to assert that all such attempts are mere covert efforts to rob Jehovah of His glory, and to assign to the laws and powers of dead matter the honor due unto His name. We must confess that with such feelings we have no sympathy.

To the unsophisticated mind the idea is a natural one that all the operations of Him who is without variableness or shadow of turning; who is the same yesterday, to-day and forever, will show a certain uniformity that will indicate identity of origin. We would not be understood as saying that throughout these works there may not be great diversity and wonderful variety; but we do think that it is natural to expect a certain markedness of character which will indicate the work of Him who forms alike the dew-drop and the universe.

Now when we examine the broad pages of the book of nature, we find just such peculiarities stamped upon every feature; and amongst these peculiarities we find none more strongly marked than the law of *gradual growth*. Wherever we turn we find that nature does not proceed by leaps, but by gradual development.

We do not find men starting instantaneously into full-grown manhood, like Minerva from the brain of Jupiter, or the armed men from the teeth of the dragon. There is first the embryo, then the child, then the man; and, under normal circumstances, the man sinks into the grave by slow degrees. So, too, the monarchs of the forest do not appear in an instant, nor in a night, nor in a year. Thousands of

years have rolled away since those tiny shoots first burst their covering in the soil of California. Gradually they grew, night and day, summer and winter, lending their influences to favor their increase. Century after century glided into the past and at length those gigantic trees, which are the wonder of the world, reared their huge forms along the coast of the Pacific. And what is true of men and of those trees is true of all else. How long did it take those diamonds to grow? And through how many years did those huge crystals of quartz attract fresh material to their shining surfaces before they reached their present size and beauty?

So numerous are the examples of this truth that it needs but expression to command assent. Every where in nature we see that the Creator works by means of physical agents; every effect is produced by comparatively slow processes; every result is obtained by *work*.

Even in spiritual matters, *growth*, whether in grace or in wickedness, is a feature obvious to every careful and candid observer. Men do not become bad of a sudden, nor can we attain spiritual perfection in a day. Aided by the spirit we must "work out our salvation with fear and trembling, adding to our faith, virtue; and to virtue, knowledge; and to knowledge, temperance; and to temperance, patience; and to patience, godliness; and to godliness, brotherly kindness; and to brotherly kindness, charity."*

Alike in the physical and in the moral world, the divine saying is true,—"The father worketh hitherto and I work." As, in the case of Naaman, it was not according to the divine system that the prophet should come out and stand and call on the name of the Lord, his God, and strike his hand on the place and recover the leper, a plan in strict accordance, not only with the ideas of the idolatrous Syrian,

*2 Peter, I., 5.

but with the ideas of most men in regard to an omnipotent God, for few of us can see a reason for the command's running: "Go wash and be clean," instead of simply, "Be clean." So, too, in the history of the creation, we find the command,—"Let there be light,"—standing forth in simple majesty, but we may also find, on careful examination, that this command involved much more than the mere calling into being of a luminous ether, or its equivalent. Many processes are contained therein; many laws were ordained to ensure their fulfilment; many forces were called into activity. And yet whether the prophet calls upon the name of his God and recovers the leper, or the afflicted Syrian makes a long journey to wash in the waters of Jordan; whether the simple command goes forth: "Let there be light," or whether general laws are ordained to produce that result, the necessity for the direct intervention of God is in all cases the same.

Hence, it does not seem to us that the attempt to deduce from natural laws an account of the process of creation can be looked upon as in any sense an attempt to set mere physical laws above the divine agency.

Had God seen fit he could have called this universe and all its inhabitants into being in an instant—in the twinkling of an eye. But he saw fit to occupy six days in the work, and shall we find fault with his plans?

There is another point which demands our attention in this connection: Granting that Jehovah is the creator and upholder of the universe; granting that he has ordained all those physical laws which govern the movements and relations of matter and force; have we any reason to suppose that he ordained one set of laws to bear sway during the period of creation, and another to regulate the world after all the various movements and processes had been set in action?

We confess that, to us, the idea that such a thing could be possible, is highly repugnant. To us, it seems much more in accordance with all that we know of the divine character, that the laws which were ordained in the first creation and which He pronounced very good, should still govern the universe. And, therefore, we believe that the light, which first poured its rays across the dark primeval abyss, was similar in its origin and in all its properties, to the light which gladdens our eyes; that the force which now draws the upthrown stone back to its mother earth, and causes that earth to roll in a certain definite orbit, "whose foundation cannot be shaken," is the same force that, on the morning of the second day, upreared the spacious firmament with all the heavenly hosts.

And in all this we can see nothing which detracts from the divine glory.

In the following pages we have adopted much of what is known as the nebular hypothesis. Towards this hypothesis, there exists, in the minds of many religious men, a feeling of decided antipathy. In so far as this antipathy rests upon a conviction that the nebular hypothesis is not well founded, we have a great respect for it, but we feel otherwise when no better argument can be advanced against it, than that it is opposed to certain preconceived notions and certain current interpretations of biblical statement.

This hypothesis has been branded as a concealed species of atheism. It might be well, for those who entertain this view, to remember that it has been received by good and pious men—men who certainly cannot be accu ed of impiety, much less, atheism.

Of this hypothesis, Whewell remarks, in his Bridgewater treatise: "If we grant, for a moment, the hypothesis, it by no means proves that the solar system was formed without

the intervention of intelligence and design. It only transfers our view of the skill exercised and the means employed, to another part of the work. For, how came the sun and its atmosphere to have such materials, such motions, such a constitution, that these consequences followed from their primordial condition? How came the parent vapor thus to be capable of coherence, separation, contraction, solidification? How came the laws of its motion, attraction, repulsion, condensation to be fixed, as to lead to a beautiful and harmonious system in the end? How came it to be neither too fluid nor too tenacious, to contract neither too quickly nor too slowly for the successive formation of the several planetary bodies? How came that substance, which at one time was a luminous vapor, to be, at a subsequent period, solids and fluids of many various kinds? What, but design and intelligence, prepared and tempered this previously existing element, so that it should, by its natural changes, produce such an orderly system? And, if in this way, we suppose a planet to be produced, what sort of a body would it be? Something, it may be presumed, resembling a large meteoric stone. How comes this mass to be covered with motion and organization, with life and happiness? What primitive cause stocked it with plants and animals and produced all the wonderful and subtle contrivances which we find in their structure; all the wide and profound mutual dependences which we trace in their economy? Was man, with his thought and feeling, his powers and hopes, his will and conscience, also produced as an ultimate result of the condensation of the solar atmosphere? Except we allow a prior purpose and intelligence presiding over this material, "primitive cause," how irreconcilable is it with the evidence which crowds upon us on every side!

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Leaving, then, to other persons and to future ages, to decide upon the scientific merits of the nebular hypothesis, we conceive that this opinion cannot, in sound reason, affect at all the view which we have been endeavoring to illustrate —the view of the universe, as the work of a wise and good Creator. Let it be supposed, that the point to which this hypothesis leads us, is the ultimate point of physical science; that the farthest glimpse we can obtain of the material universe, by our natural faculties, shows it to us, occupied by a boundless abyss of luminous matter; still we ask, how space came to be thus occupied? If we establish, by physical proofs, that the first fact which can be traced in the history of the world, is that "there was light," we shall still be led, even by our natural reason, to suppose that before this could occur, God said, "Let there be light."

CHAPTER II.

Matter and Force.

The world in which we live may not inaptly be compared to a large library, in which each rock, each plant, each animal, represents a volume, more or less elaborately composed by its Divine Author. And as, in a library, we find each book made up of sentences, which, in turn, are composed of words, while these words are themselves compounded of a comparatively small number of letters, so in nature we find that the matter of which rocks, plants and animals are composed may be resolved into some seventy or eighty letters or elements. A full account of these elements may be found in any of our standard works on chemistry.

But other agents besides matter are concerned in the physical phenomena of the world around us. All matter seems to be associated with force. The force of the sunlight falling upon the leaves of the forest is absorbed, if we may use the expression, and becomes associated with matter. That association may continue for hundreds or for millions of years and yet stand ready at any moment to be sundered at the behest of more powerful agencies. Thus the carbon deposited in the coal mines of Pennsylvania has lain there for untold ages, but daily it is made to yield up its associated powers which are again called into the roll of active agencies. At one time it smelts the iron ore in the neighboring valleys and worthless dirt is transformed into shining metal through the agency of the same affinities that built the mighty columns of the primeval forests; at another

time its stores of power are evolved in the form of mechanical force, and the steamboat is propelled, and the lightning train hurried along its iron path by means of energies which for long ages have quietly slept beneath the green turf of the mountain side; while in another form it illumines our streets and our assembly rooms with the buried sunlight of a million years ago.

But these forces, as they exist around us, are silent and apparently inactive and oftentimes we forget that they have any existence; or, if we look for them at all, we are apt to seek them where they are least to be found. The great works of nature are done in silence and in quiet, and we, ignorant that we are, look for the manifestations of power amid noise and tumult, forgetting that the forest, whose mighty trees are sufficient to form navies and build palaces, was built up atom by atom, in silence and stillness. And yet the labored pillars of the glorious palace of the wise king of the Jews were not more wonderfully constructed or more beautifully ornamented than are these living columns.

When *we* look for power, we seek it amidst the great commotions of nature. Standing by Niagara, we regard it as a peculiar instance of the immensity of divine power, and so it is. But we forget that it requires more force to ripen the cornfields of Ohio than would be evolved by ten Niagaras. We stand by the ocean, when its billows, under the influence of a wild tempest, are heaved and tossed to and fro, and we look upon it with wonder and with awe; but we forget that an hour's gentle sunlight, falling upon the bosom of that same ocean and raising its waters in fleecy clouds to the sky, gives out as much power as would be required to produce the fiercest tempest that ever struck terror to the heart of a navy.

Truly we have not yet reached the depth of meaning

contained in that wonderful vision in which the prophet was taught that it is not in the whirlwind, though it be great and strong, rending the mountains and breaking the rocks; not in the earthquake; not in the fire; but in the still, small voice, that the very presence and power of Godhead has its abiding place.

Consider that goblet of water—so pure, so limpid. Did you ever think of its wonderful history and of the good of which, during thousands of years, it has been the untiring agent? Long ages, before man came upon this scene, it received its existence from the hand of the Great Creator, and on that third morning of creation, when the seas fled before the face of Jehovah, it heard and obeyed his voice, and the dry land appeared. But the sun, with his burning lips, kissed the bosom of the great deep and raised it in fleecy clouds to

> "Bear light shade, for the leaves when laid,
> In their noon day dreams."

And then it fell on the distant hill-tops and the tender grass rejoiced as it sparkled in the morning sun. It rippled down the mountain side and the valley smiled in beauty and in fragrance; it hung in silvery pearls on the spray, and the woodland songsters sipped its nectar and warbled forth their praise; it lay in dewy drops upon the rose leaves, as pure—we had almost said as beautiful as they; more beautiful still, it fluttered from the clouds in pure and snowy flakes and clothed the earth as with a garment, that the tender plants might not feel the keen northern blasts.

Wherever it has gone it has carried mercy, and health, and pleasure. The fevered lip of the wounded warrior has groaned for it; the little child, tossing in burning delirium on its pallet, has stretched forth its feeble hands for it; it

has laved the brow of beauty and made it more beautiful still, and it has carried health and happiness to the poor man's home.

And yet the contents of this goblet, so delicate that it might lave an infant's cheek without injuring it; so limpid that the finest thread of gossamer might divide it and sustain no harm, contains within its bosom, forces, which, if suddenly liberated, would prove more terrible than the fiercest storm. No bombshell, that ever tore up a battle-field, carries more powerful elements of destruction in its bosom than exists in that goblet of water. Nor is this the startling paradox of the theorist. No fact in chemistry is more fully substantiated than that the atoms of each drop of water are held together by forces of greater energy than is required to produce a powerful flash of lightning. Thus, Faraday, in his "Electrical Researches," tells us:

"It is wonderful to observe how small a quantity of a compound body is decomposed by a certain portion of electricity. Let us, for instance, consider this and a few other points in relation to water. *One grain* of water, acidulated to facilitate conduction, will require an electric current to be continued three minutes and three-quarters of time to effect its decomposition, which current must be powerful enough to retain a platina wire, $\frac{1}{104}$ of an inch in thickness, red-hot, in the air during the whole time; and, if interrupted any where by charcoal points, will produce a very brilliant and constant star of light. If attention be paid to the instantaneous discharge of electricity of tension, as illustrated in the beautiful experiments of Mr. Wheatstone, and to what I have said elsewhere on the relation of common voltaic electricity, it will not be too much to say that this necessary quantity of electricity is equal to a very powerful flash of lightning. Yet we have it under perfect command;

can evolve, direct and employ it at pleasure; and when it has performed its full work of electrolization, it has only separated the elements of *a single grain of water*.

"On the other hand, the relation between the conduction of the electricity and the decomposition of the water is so close, that one cannot take place without the other. If the water is altered only in that small degree, which consists in its having the solid instead of the fluid state, the conduction is stopped and the decomposition is stopped with it. Whether the conduction be considered as depending upon the decomposition or not, still the relation of the two functions is equally intimate and inseparable.

"Considering this close and two-fold relation, namely, that without decomposition transmission of electricity does not occur; and that, for a given definite quantity of electricity passed, an equally definite and constant quantity of water or other matter is decomposed; considering, also, that the agent, which is electricity, is simply employed in overcoming electrical powers in the body subjected to its action; it seems a probable and almost an inevitable consequence, that the quantity that passes is the *equivalent* of, and therefore equal to, that of the particles separated; *i. e.* that if the electrical power which holds the elements of a grain of water in combination, or which makes a grain of oxygen and hydrogen, in the right proportions, unite into water when they are made to combine, could be thrown into the condition of a *current*, it would exactly equal the current required for the separation of that grain of water into its elements again.

"This view of the subject gives an almost overwhelming idea of the extraordinary quantity or degree of electric power which naturally belongs to the particles of matter; but it is not inconsistent in the slightest degree with the facts which can be brought to bear on this point.

"What an enormous quantity of electricity, therefore, is required for the decomposition of a single grain of water. We have already seen that it must be in quantity sufficient to sustain a platina wire $\frac{1}{104}$ of an inch in thickness, red-hot, in contact with the air, for three minutes and three-quarters, a quantity which is almost infinitely greater than that which could be evolved by the little standard voltaic arrangement to which I have just referred. I have endeavored to make a comparison by the loss of weight, of such a wire, in a given time, in such an acid, according to a principle and experiment to be almost immediately described; but the proportion is so high that I am almost afraid to mention it. It would appear that 800,000 such charges of the Leyden battery, as I have referred to above, would be necessary to supply electricity sufficient to decompose a single grain of water; or, if I am right, to equal the quantity of electricity which is naturally associated with the elements of that grain of water, endowing them with their mutual chemical affinity."

But the hand of God has been laid on these mysterious agents and we move about among them, scarcely conscious of their presence. They are obeying his will and are angels of mercy, not messengers of wrath.

It is true that, as ordinarily associated with matter, the chemical and electrical forces are not directly obvious to our senses. They exist in that condition which has been termed *latent*. Now this term *latent*, though a very good one in some circumstances, has produced more misconception, in regard to the physical forces, than any other word in use.

Take, for example, the phenomena of heat as it becomes latent in steam. We all know that if water be heated, after it reaches the boiling point, no subsequent addition of heat produces any elevation of temperature, but the water

is gradually converted into steam, and this steam has the same temperature as the water from which it was formed, viz: 212° Fah.

But if we collect a pound of this steam and condense it, so as to abstract the heat from it, we get enough of heat to raise many pounds of water from the ordinary temperature to the boiling point.

Now where was this heat which disappeared in the steam and reappeared again when it was condensed? We say that it was *latent*, and we speak correctly if by *latent* we mean that it was hid from the direct observation of the senses. But if by *latent* we mean that it was dormant and inactive, we commit a great error. Dormant, it certainly was not. It had its own work to perform the while and it could not do that and raise the mercury in our thermometers too. It held the particles of water asunder so that they occupied nearly two thousand times the space they did before, and when the power which held them so apart was withdrawn, they rushed together and formed either a liquid or a solid, according to the amount of heat absorbed.

In the case just cited, matter and the physical forces acting on it, may be compared to two athletæ struggling for the mastery. See how they strain, and tug, and heave. Every muscle is tense, every nerve strained and their movements are made with the celerity of thought and the sharpness of the lightning stroke. No want of power there, no lack of evidence of its existence. But now see. They have clinched for the final effort, but the strength and will of each is so nicely balanced, that neither has the advantage, and there they stand as still and rigid as two statues carved in marble. But is there no force there, or is that force dormant? The rigid limbs, compressed lips and unbreathing effort show that if any ordinary resistance were opposed to

the power exerted, the opposing body would be hurled into the air as from a catapult, or dashed prostrate on the earth. In this case we do not associate want of power with apparent inactivity ; we know that the very stillness denotes the greatness of the exertion.

And so with the material elements. The materials composing most of the objects around us are held together by forces, which, *from the very work which they are performing*, are concealed from our view.

As, in order fully to comprehend the subject of the correlation of the forces and the relation of matter and force, it is necessary that we should have clear ideas in regard to what may be called *latent* or concealed force, we will endeavor to present the question in another, and, perhaps, a still more forcible light.

It is a generally received opinion that all gases are merely vapors of liquids that boil at very low temperatures. Thus, while water boils at 212°, common ether boils at 96° and sulphurous acid at 0°. Consequently, while water is always a solid or a liquid, in all parts of the earth, ether would be a permanent gas in any place where the highest tropical temperature prevailed, and sulphurous acid is always a gas except in the cold of the polar regions. Even the dense and brilliant metal, mercury, when exposed to a temperature sufficiently high, becomes, in reality, a perfectly colorless and transparent gas, and carbonic acid gas, when exposed to a temperature sufficiently low, becomes first a yellowish, oily-looking liquid and then a beautiful snow-white solid. The only difference, then, between common snow and carbonic acid snow, is, that the one is much colder than the other, while, on the other hand, the only difference between carbonic acid gas and mercury gas, is, that the one requires a higher temperature for its existence than the other. There

are certain gases, however, which no degree of cold yet reached, has reduced to the liquid, far less to the solid form. Prominent among these are oxygen and hydrogen—the two gases, that, when combined, form water. But, after it had been observed that intense cold tended to reduce all gases and vapors to the liquid form, it was supposed that, if hydrogen and oxygen could only be made cold enough, they would become liquid too. So they were cooled with freezing mixtures but still they remained in the gaseous state. Then a still more powerful freezing agent (solid carbonic acid) was used. But, although mercury became solid, and alcohol, unless very pure, became thick and pasty, instead of clear and limpid, still hydrogen remained unaltered. After a time a still more powerful freezing agent (liquified laughing gas) was discovered. Natterer, of Vienna, made a powerful steel pump and pumped laughing gas into a large iron receiver or bottle until it became liquified with the pressure. When a little of this liquid was poured into the air it evaporated and produced the greatest degree of cold ever observed —a degree of cold 257° below the zero of Fahrenheit's thermometer. Of such a temperature we have but a very faint idea. Let us begin at the temperature of our own bodies and, gradually descending, by well known stages, see if we can realize the fearful degree of cold that is expressed by 257° below zero.

Human existence requires a temperature in the neighborhood of 100°, a temperature which, under ordinary circumstances, is easily maintained by the chemical and vital actions going on in the system, whenever the external atmosphere does not sink below 60°. When the temperature of the surrounding air falls below 60°, the animal carries on a continual fight for the maintenance of its normal temperature. At thirty two, the contest becomes more energetic.

Warm clothing is called into requisition, and, if the air should be agitated by keen winds, the clothing must be warm and the fuel (food) liberal or the animal will suffer. When the temperature sinks to zero, even, on a clear, still day, there are few persons that do not feel it keenly, and, if any wind should be stirring, ugh! how cold it is! But, keenly though we feel it, we have just begun to descend the scale. Let us take a leap down to –40°: The mercury in our thermometers will now congeal, and, if we find it necessary to expose ourselves, we must encase our persons in triple layers of fur. Let us take another leap, of equal magnitude, and descend to –80°. This is lower than any natural temperature ever observed and it is improbable that human life could be long sustained in an atmosphere cooled to this degree. At six degrees below this point, carbonic acid condenses to a liquid and the breath of our nostrils would condense as it issued forth and would fall to the ground in streams. Forty-four degrees below this point carries us to –130°. If such a temperature could be produced over a large area, what strange phenomena would present themselves! The air would be dry—dryer than the summer dust—for all moisture would have been precipitated from it long ere this temperature had been reached. No animal could breathe such air, and if plants could live and perform their functions at such a low temperature, they could find no sustenance in an atmosphere as cold as this, for all the carbonic acid would descend to the earth as beautiful white snow. The breath from the nostrils of every animal, provided animals could exist, would yield a shower of these flakes and the air would be entirely purified from the products of respiration. And yet we are not half way down to the point reached by Natterer. He went twice as far, and, even then, oxygen and hydrogen did not liquify, but maintained their condition as clear and beautiful gases-

But, cold alone was not the only agent brought to bear on these gases for the purpose of reducing them to the liquid form. They were subjected to immense pressure, a pressure far exceeding anything with which we are familiar in ordinary life. It is well known that if water be subjected to great pressure it will remain a liquid at temperatures far above the boiling point, although, if exposed to the air at that degree of heat, it will become a clear vapor which cannot be distinguished from a true gas. Nitrogen, oxygen and hydrogen are undoubtedly liquids at some very low, though unknown, temperature. Their boiling point is probably a great deal lower than 300° below zero; the boiling point of carbonic acid is 80° below zero; the boiling point of water is 212° above zero; and the boiling point of mercury is 600° above zero. And just as water may be heated far above 212° and still remain a liquid, provided it be subjected to great pressure, so it was thought that oxygen and hydrogen gases might be subjected to what was, for them, a very high temperature, (–257°) and yet remain a liquid, provided the pressure should remain sufficient. So Natterer constructed a series of very finely made steel pumps. With one of these he condensed one of the gases into a strong vessel until it occupied but the three hundreth part of its original bulk. Then, with a still more powerful pump, he condensed this already dense gas so as to reduce it still further. It will readily be seen, that, by employing gas in a condensed state, it was much easier to force it through the valves of the second pump than if gas at the ordinary pressure had been used. In this way, by working with gas gradually increasing in density, he finally obtained a pressure of 3,000 atmospheres. Now, our readers know that the atmosphere presses on each square inch with a force of 15 lbs., or rather less, consequently, 3,000 atmospheres would give us 45,000 lbs.,

or 22½ tons per square inch. If we have no idea of a temperature of 257° below zero, neither can we fully grasp the enormous pressure expressed by the figures 45,000 lbs. per square inch. Most solid substances would be crushed to powder under such a pressure as this. And yet to this wonderful pressure did Natterer subject oxygen and hydrogen. But even a cold of –257° and a pressure of 45,000 lbs. per square inch made no impression on them, at least, so far as change of form is concerned.

But that which Natterer, aided by all the resources of modern science, failed to do, chemical affinity does instantly and perfectly. Mix the gases in proper proportions and bring the smallest flame into contact with them so as to produce ignition and they will instantly rush together with a loud report, combine and form a perfect liquid — water. It is perfectly obvious that the elementary atoms of this new liquid — water — must be held together by a force sufficient to overcome their expansive force. We have seen what this expansive force is capable of resisting, and consequently we can form a comparative estimate of the power of chemical affinity. If this be so, is our statement in regard to the forces *latent* in a cup of water overcharged?

It is still an unsettled question whether there are various forces, or whether all are not manifestations of one general force. It is even a question of dispute as to whether there is such a thing at all as force, that is to say whether or not *force* may not be merely a condition of matter.

Whatever be the theoretical view which we may take of this subject, the phenomena with which we are chiefly concerned, will remain unaffected. No future change in chemical theories can ever affect the fact that the gases which we call oxygen and hydrogen will explode when they are mixed in certain proportions and ignited ; no new views of chemi-

cal and electrical action can ever rob the battery of its power or take away its ability to effect certain decompositions; and no new developments can ever annul the fact that when the motion of a body is destroyed, its temperature is raised.

Whatever view we take of force, however, it is evident that there are various modes of manifestation which differ very widely amongst themselves. Heat, Electricity, Chemical Affinity and Gravity all produce results which are markedly different.

It has been said by some that there is such a unity in nature that it does violence to our ideas of the fitness of things to suppose that there can be more than one kind of matter or one form of force. Such reasoning, however, is obviously based upon a very narrow generalization.

Individuality, or, in other words, diversity, rather than unity, seems to be the marked feature of creation. No two leaves in the forest; no two grains of sand on the sea-shore; no two of all the individuals of the human race that ever trod this earth were ever so precisely alike that a higher intelligence could have mistaken one for the other. Every one has been stamped with its own individuality, and we see no reason why the same may not be true of the material elements and of the forces.

The question of identity can only be solved by a sufficiently wide generalization of facts—not by any *a priori* reasoning.

But, however this may be; whether there be one force or several, this much is certain, that one force can often do the work of another, and so eliminate it, and as it were, set it free.

Thus heat if sufficiently intense eliminates light; chemical affinity gives rise to light, heat and electricity, and so on of the others. This curious chain of relations is known as

the *correlation of the forces* and is one of the most wonderful of all the modern developments of science.

It would be impossible to enter here into a full discussion of this subject, nor is it necessary, as there are various works now before the public in which the matter is fully presented. We must rest content with a mere statement of the general result.

Amongst all the various forms or modes of force, there is only one which has not been correlated with the others, and that one is gravity. Heat, Light, Electricity, Magnetism, Cohesion and Chemical Affinity may each be made to produce (if we may be allowed the expression) all the other forms, or, at least, to modify their action. Gravity alone stands aloof. But gravity is so far connected with the other forces that it is capable of giving rise to motion, and this motion is an efficient agent in producing the other forms of force. Thus, whenever motion is arrested, heat is invariably produced. And, if the heat produced be sufficiently intense, light is never absent. The amount of heat and light which can be thus produced by the conversion of motion is something wonderful.

The savage, by the friction of two pieces of wood, generates an amount of heat sufficient to produce fire ; I have myself, by laying it on an anvil and striking it rapidly, rendered a piece of iron sufficiently hot to inflame sulphur ; the cannon balls which strike an iron target are always rendered intensely hot, and in many of the experiments at Shoeburyness, a brilliant flash of light was seen when the ball struck the target.

But all these instances pale before the intense degree of heat which the most rigorous calculation shows us would be produced by arresting the motion of bodies moving with the velocity of the members of our solar system.

"Our earth moves in its orbit with a velocity of 68,040 miles an hour. Were this motion stopped, an amount of heat would be developed sufficient to raise the temperature of a globe of lead, of the same size as the earth, 384,000 degrees of the centigrade thermometer. It has been prophesied that the 'elements shall melt with fervent heat.' The earth's own motion embraces the conditions of fulfillment; stop that motion, and the greater part, if not the whole, of her mass would be reduced to vapour. If the earth fell into the sun, the amount of heat developed by the shock would be equal to that developed by the combustion of 6,435 earths of solid coal.'" (*Tyndall.*)

Whenever, then, bodies are in motion and this motion is destroyed, heat and light are the result. If we find no heat and no light, we may be certain that no bodies are falling together in obedience to the other forces. Hence, when we are told that "darkness was upon the face of the deep" (abyss,) we feel certain that in that abyss, either the physical forces were not, or their powers were held in abeyance.

CHAPTER III.

The Beginning.

Science, as well as revelation, points to a "beginning." Geology points to a time when man did not inhabit the earth—when for him there was a beginning. So too for lower organisms; so too for the rocky minerals; so too for the round world itself. That it has existed for a finite and definite, although unknown, period, all science testifies; and revelation tells us that it was made by God, and that at first it was "without form, and void." The precise meaning of this term "without form, and void," is still under discussion, although commentators seem generally inclined to accept the form "waste and desolate"—a term which certainly complies with all the requirements of the original language. But at the same time, if what we mean by "waste and desolate"—that is, if a universal Sahara fulfils the condition indicated by the words "without form and void," much more does that state in which science indicates that the world at first existed. We must remember that the terms are meant to be emphatic; that not only man, but animals and plants were as yet uncreated. Even the dry land had not appeared, and there was no division of the waters which were under the firmament and the waters which were above the firmament. A mere desert, or a simple globe covered with water, would hardly comply with the conditions here required. We are afraid that those who adopt the terms "waste and desolate," as equivalent to "without form, and void," introduce into their ideas too

much of the feeling that localities in which the wants of humanity can not be supplied, may be called "waste and desolate." Such thinkers should remember that many things were pronounced good by God before man's requirements had presented themselves.

"It would not be a painful, but a pleasant thing, surely, to learn that some of the stars, such as the new planet Flora, were great gardens, like Eden of old before Adam was created; gardens of God, consecrated entirely to vegetable life, where foot of man or beast had never trod, nor wing of bird or insect fanned the breeze; where the trees never crackled before the pioneer's torch, nor rang with the woodman's axe—but *every* flower was

'Born to blush unseen,
And waste its sweetness on the desert air.'

Neither is it the remembrance of the Arabian Nights, nor thought of Aladdin's lamp, that makes us add that we should rejoice to learn that there was such a thing as an otherwise-uninhabited star, peopled solely by magnificent crystals. What a grand thing a world would be containing, though it contained nothing else, columns of rock crystal like icebergs, and mountains of purple amethyst, domes of rubies, pinnacles and cliffs of emeralds and diamonds, and gates and foundations of precious stones, such as John saw in the Holy Jerusalem descending out of heaven! All who reach the happy land are to enter heaven as little children; and it may please God, besides other methods of instruction, to teach His little ones His greatness and power by showing them such a world as we have imagined."*

Planets answering to this description could not be said to be "without form, and void," nor would they to the eye of

* Religio Chemici, p. 53.

God be "waste and desolate." Let us then retrace the history of our planet and endeavor to discover a period at which it could be said of it that it was "without form and void."

At this period it was evidently not any such earth as that which we now see beneath our feet—flowers springing up on every hand, purling brooks winding their way back to their great mother the ocean; an earth filled with the singing of birds, and across whose thousand hills the cattle roam. Nay, more than all that; an earth in which is enshrined the hopes and fears, the loves and hates, the aspirations and despondencies of uncounted hosts; an earth filled with humanity on its surface, and beneath whose sod lie the graves of interred millions, with all their hopes of a glorious resurrection. Nothing like this; for of such an earth it could not be said that it was "without form, and void."

Was it then when huge volcanic masses lay piled in gigantic heaps over the face of the earth? when as yet the softening influence of time had not weathered the rough mountain's brow, whose blasted and withered surface was seamed by many a lightning stroke? when dense gases and hot vapors gushed from a thousand springs, and produced black and heavy clouds, which wrapped the whole earth in darkness, shut out the light of day, and cast back the red and lurid gleams of unnumbered volcanoes, as with fitful flashes they lit up the horrid scene below? when steaming rivers rolled their muddy streams over fiery beds to a seething ocean? when, instead of crystal lakes and pellucid ponds, the valleys held but the boiling and foaming *caput mortuum* of a Titanic distillation? when no wing clove the murky air, and no sound was heard save the heavy boom of volcanic explosions? Even then the earth had "form," and it was not "void;" and to a higher intelligence, free

from the physical wants of humanity, it would not have been either "waste" or "desolate." The physical laws ordained by the Creator bore sway over every part, and the most perfect order governed every phenomenon—the growth of crystals, the flow of streams, and the condensation of vapor.

Was it then while this globe hissed through space a fiery mass of molten matter, and, like a baleful star, threw her red and glaring light upon her sister planets? Not even then, for liquid though it was, it had form and shape. Are the pearly dew-drops which at dawn glisten in the rays of the new-born day without form? Far from it. Beautiful they are in their purity and pellucid yet silvery lustre; but lovely they are too from their perfect *form*.

In none of these conditions, then, could the earth have been said to be without form; therefore we conclude that the beginning to which science and revelation alike point, was a period when this round world had no being as such; to a time when its atoms had not been brought together; to an age when it existed merely as floating vapors—the laws of gravitation not having as yet arranged its atoms, and the laws of chemistry not having united the elements of which it is composed; in a word, to a period when it was really "without form and void," and when darkness was over the abyss in which it lay.

It is evident that by the heavens and the earth is here meant simply the material universe. Heaven, we are told, was the work of the second day; and on the ordinary systems of interpretation, this fact introduces some confusion. But if we accept the terms "heavens and earth" in their ordinary sense, as meaning simply the *materials* of which the earth, sun, moon and stars are composed, we shall find that all confusion disappears. The earth, sun, moon and

stars themselves were not at this time created as distinct individuals, but, called into being at the fiat of Him who "made not the things which are seen out of things which do appear," the materials of which they are composed floated through space as mere nebulous matter — utterly inactive, and utterly dark.

CHAPTER IV.

The Days of Creation.

As may be seen in the works of Nott & Gliddon, quoted in a subsequent page, the infidel and the scoffer have ridiculed beyond measure the idea of there being "days" and light before the creation of the Sun, and even the learned father, Augustine, long before Geology had made any claims to the rank of a Science, exclaimed, in reference to the days before the creation of the Sun, "What mean these days, these strange, sunless days?" Indeed no point connected with the Mosaic record has given rise to more discussion than the nature and duration of the days of creation. In general, two meanings have been applied to the word day. By some it has been held to mean a day of twenty-four hours, while others have regarded it as signifying an indefinite period, embracing many such days. The latter definition has been adopted by most of those authors who have sought to reconcile the Mosaic and the Geologic records, while the first definition has in general found favor with linguists and theologians, and those who fail to appreciate the force of scientific evidence. Thus the learned Hebraist, Kalisch, says: "It is philologically impossible to understand the word day in any other sense than as a period of twenty-four hours."

To us it seems that, if language has any definite meaning at all, the term day has been so fully defined by the inspired author as to leave no doubt as to its meaning. Let us

see what that definition is. In verses 4 and 5 we read: "And God saw the light that it was good; and God divided* the light from the darkness. And God called the light, day, and the darkness he called night, and the evening and the morning were the first day;" (or, as the passage may be more literally rendered—"and there was evening and there was morning—day one.")

Here it will be observed that in conformity with common usage we have two distinct meanings given to the word day. By day in the first instance is meant that period of light which succeeds the darkness or night, while in the second the word day *includes* also a period of darkness or night, just as we say ten days—meaning thereby ten days and ten nights—the word day here including both.

In its broader sense then, a day is here defined as a period of darkness *and* a period of light, and the duration of these combined periods is not, by any means, confined to twenty-four hours, either in common language or in the words of the text.

Was the *day* in which Joshua smote the Amorites not a "day," because its duration was nearly doubled? The sacred writer calls it a day, although he tells us that "there was no day like that before it nor after it." And when we go to the North Pole and find the Sun circling round the horizon for months without any evening or darkness, must we do violence to the sacred definition, and say: sometimes

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* The word here rendered, *divided*, may perhaps be more properly translated, *distinguished between*. We do not propose to base our interpretation of this chapter upon any forced translation of the sacred text, and we would not have suggested the above alteration if the amended form which we propose, had not been very old and common.

In an old bible published at Basle, in 1534, we find the following Latin translation of the Hebrew text—the original and the translation being printed in parallel columns. (We give it verbatim et literatim:)—"In principio creavit deus coelum & terra. Terra aute erat informis & inanis, & tenebrae erant super facie abysi: & spiritus dei movebat se super facie aquaram. Dixitquo deus: fiat lux & facta est lux.—Et vidit deus lucem quod esset bona: & dietinxit *(distinguished)* deus inter lucem & inter tenebras. Vocavitque deus lucem diem, & tenebras vocavit nocte: & fuit vespera fuitque mane diee unus." (And evening was and morning was one day.)

evening and morning are one day, but in higher latitudes one morning is long enough to make a great many days? Yet we certainly cannot see how this is to be avoided if we adopt the definition given by Kalisch and others.

But let us consider particularly the *first* day and examine the biblical definition of a day, as applied to it. The inspired author tells us that in the beginning there was darkness upon the face of the deep, and then he adds that God said "Let there be light," and there was light; and further we are told that "the evening and the morning were the first day." The question then occurs, does the evening here mentioned cover the entire period of darkness alluded to as existing prior to the ordaining of light? And if not, by what authority are twelve hours more or less detached from this long period and called the first evening? And if it be claimed that the first "evening" covers the whole period of preceding darkness, then by what authority is it claimed that this darkness was limited to twelve hours or twenty-four hours or twenty-four billions of hours, and, consequently, where is any authority found for limiting the duration of the first day to twenty-four hours? At present we find that every twenty-four hours brings round a period of light and a period of darkness, which we call a day. The duration of this period is governed by the rotation of the earth on its axis, and with us, therefore, a day is twenty-four hours. Suppose that some cause other than the rotation of the earth should produce the alternation of night and day, would the duration of the day still be twenty-four hours, or might it be something else?

To us it seems clear, beyond all possibility of doubt, that God has not seen fit in this case to define a day to be twenty-four hours, nor does he declare that it depends upon the period required by the earth for a rotation upon its axis;

and those who superadd these conditions to his definition evidently exhibit a disposition to be wise above that which is written. Indeed we are expressly told that the Sun did not govern the day until the fourth period, and hence to us it seems obvious that a day is simply an evening and a morning—a period of darkness and a period of light; and that the *duration* of such day is not at all limited by any thing contained in the text.

In this connection we may note the peculiarity of arrangement—the evening being placed *before* the morning—an unusual thing with us and evidently based upon the fact that in the order of creation, evening preceded morning—darkness was before light.*

Now if we can find in the scientific record of creation, six periods of darkness and six periods of light: if further we find that during the first four or five of these periods, the work indicated by science and the work laid down by Moses agree most perfectly, while for the fifth and sixth the probability of agreement is very great, does not the evidence as to the truth of the Mosaic account, and the correctness of our interpretation of it, amount almost to a demonstration.

We hope to present strong scientific grounds for the belief that there *were* six such periods of darkness and light during the creation of this globe, and that these periods coincide exactly with the six days of Moses.

Upon the value of this evidence in favor of the divine origin of the Pentateuch, it is unnecessary to enlarge. We therefore proceed to an examination of the process of creation as indicated by science, comparing it day by day with the record given by Moses.

* We are aware of the peculiarities of Eastern nations in this respect, and also of the Gothic nations in numbering by *nights* instead of days, (fortnight, se'nnight, &c.,) and winters instead of years, but this does not detract from the coincidence in the text.

CHAPTER V.

The First Day.

We have already observed that the statement "Darkness was upon the face of the deep," indicates the entire absence of active physical force. If either chemical action, gravity, or any other of the known forms of force had been at work, light would have been produced, and the universe would not have lain in darkness. But God had not as yet seen fit to call these forces into action. Whether they existed at all or not is a question that lies beyond the reach of human knowledge. They may have existed from that beginning when God created the heaven and the earth; or they may have been called not only into activity, but into being at that word of the Almighty which commanded the bursting forth of light. By ordinary minds it is not found impossible, or even difficult, to conceive of matter as existing without associated force. We see two bars of steel—one powerfully magnetic, and the other perfectly free from magnetism. Yet one is just as much steel as the other. And so of electricity, light, heat, etc. Excellent philosophers have entertained the idea of an absolute zero, at which bodies were divested of all heat, and became mere matter—so far as that particular form of force is concerned.

And so too of gravity. True we find no case in which bodies do not exert an attraction for surrounding masses, but we find no difficulty in conceiving of two bodies which would lie side by side forever in a quiescent condition. And yet a well-known writer on chemical subjects states that it is impossible even to think of matter unassociated with force.

This point, however, although one of deep interest, does not greatly affect our present subject. The Mosaic record tells us that at one time darkness was upon the face of the deep, and science equally declares that matter was most probably diffused through space in the form of atoms which did not act upon each other. Under any circumstances, it is more than probable that if gravity had not yet acted upon the atoms of this floating matter, neither had chemical affinity. Let us then consider what would be the effect of calling into action the forces which we have mentioned, and also what would be the order of the phenomena.

Such a consideration carries us back in imagination to that beginning when the "heavens and the earth" had just been created; but when as yet there was no sun, no moon, no stars—nothing but a vast abyss, thinly peopled by the ultimate atoms of matter; the whole universe being enveloped in darkness, compared with which the gloom of the darkest night is but a cloudy day. It was truly the reign of Nox and Erebus. There was no motion, no heat, no sound, no life. Nothing existed but dead matter and that Spirit who

> ——— "from the first
> Was present, and, with mighty wings outspread,
> Dove like sat brooding on the vast abyss,
> And made it pregnant."

But now the fiat of the Almighty goes forth. He says "Let there be light," and instantly throughout the wide expanse is felt the force of new activities, while morning—the first morning of creation—breaks over all.

Soft and nebulous at first, it lights up the dark corners of the universe with the beauty of a summer twilight. Gradually it increases, until the heavens are aglow, and light more brilliant than the fiercest tropic noon exists everywhere.

Not light from a sun here, and a star there, pouring their feeble rays across the darkness—for as yet there was no sun, no moon, no stars—but light *everywhere*, until space itself seemed to be luminous with light so bright that the beams of the sun himself, if he had then existed, would have been drowned in the radiant flood.

By what process was this result attained? Light, as we have seen, may be the result of many different physical processes. Prominent amongst these are chemical affinity and mechanical action—the latter, in most of the cases occurring in nature, being due to the influence of gravity.

Now let us suppose that the expression "Let there be light," is but a modified form of the command "Let the physical forces act upon matter;" the one being the expression of the *means*, while the other, in more sublime form, simply states the result. Instantly the atoms throughout the universe would fall toward *each other*. It is true that they would also fall toward some one or more definite centre or centres; but on their path toward these centres they would undoubtedly fall towards each other—just as two balls of lead or other heavy substance, suspended by two strings, are attracted, not only by the earth, but by each other, and consequently never under such circumstances hang *perfectly* plumb. They would thus be brought within the sphere of chemical action; and combustion, with the production of light and heat, would be the result. That most of the elements would enter into combination by mere contact, and without the agency of a preparatory elevation of temperature, is beyond all doubt. Iron and lead, when reduced to a sufficiently fine state of division, burn when simply poured into the air. The metals of the alkalies combine with oxygen, even when in masses of considerable size; and, at all ordinary temperatures, chlorine enters into

combination with most of the metals, in whatever way they may be presented to it.

It is therefore tolerably certain that if iron, lead, magnesium, calcium, aluminium, and the other easily-oxidable metals were mixed with oxygen, chlorine, &c., in the state of gas or vapor—as they would be if freed from the influence of cohesion and gravity—as soon as gravity, cohesion and chemical affinity were set in operation, they would move towards each other; combination would ensue, and we would have an almost infinite number of small masses, which, from the intense chemical action, would be in a state of ignition, and whose particles, when they had cooled to the proper temperature, would be held together, not only by gravity, but by cohesion. Such masses would probably resemble our meteorites; and when they had become cold, they would give off no light when merely existing in space or passing through it, unless a multitude of them were brought together, or unless they became heated by passing through the denser atmosphere of some large body, like the sun or the earth.

It is also more than probable that this state of chemical action would go on throughout the whole universe. It is very unlikely that it would commence at any definite center, and consequently we have every reason for believing that the entire universe was filled with one glow of light. The amount and intensity of light which would be produced by such a conflagration is something of which we can form but a feeble conception. The following illustration may serve to convey some faint idea of the intensity of the light of the first day:

The one-thousanth part of a pound of magnesium wire, burned in the open air, will give a light which will last during one second, and can be seen at a distance of thirty

miles. It will illuminate a large hall so that the furthest corners will be brilliantly lighted. If then we take into consideration the single metal magnesium, and reflect upon the amount and intensity of the light which would be produced by the combustion of the quantity which enters into the composition of the rocks which form many of our mountain ranges, we cannot fail to see that the combustion of the other metals, together with the carbon (now existing as coal, carbonates and carbonic acid), sulphur, phosphorus, &c., of our earth alone, would illuminate a very large space in the heavens. The earth, however, forms but a small fraction of the enormous stores of light-giving material which were consumed when God said "Let there be light." Nay, even the sun, whose mass is equal to that of 354,936 earths like ours, is but an infinitesimal portion of the whole.

And by these means, doubtless, it pleased God to produce the light of the first day—that day which was called into being, not by the creation of the sun, but by simply calling into action the physical forces. Can any one reflect on these things and say that our description of the first day is exaggerated?

The account given by Moses of this first day is unequalled for its beautiful simplicity and its strict accuracy. True, it has been ridiculed beyond measure—but only by men who were ignorant alike of the power of God and the first principles of chemistry.

CHAPTER VI.

The Second Day.

But the first day gradually draws to a close, and night comes on apace. What, then, were the causes which gave rise to the second period of darkness and the second period of light—that darkness and that light which has been described in the words, "and the evening and the morning were the second day?"

In addition to the chemical action which we have described, there would be another agency at work tending to produce light and heat. This would be the mechanical action produced by the motion of the particles towards each other, and which would be converted into heat when these particles came together.

At first, however, but little light would be produced by this agency. The motion towards each other of the masses which we have described, would, during the first few millions of years, be unquestionably very slow; and not until a sufficient amount of matter had accumulated round some definite centre or centres, would any light at all be given off.

It is a truth taught in every public school, that bodies existing in space attract each other with a force which is directly as the masses and inversely as the squares of their distances from each other. Experience has taught us that by most persons who have not given particular attention to the subject, gravity is regarded as a very powerful force, whereas it is, in a certain sense, one of the feeblest. Com-

pare it, for example, with the force of cohesion. The attraction which exists between a single layer of particles extending across a very slender wire of steel, is much more powerful than the attraction which exists between even such a large body as the earth and another body of the size and weight of a man. This is shown by the fact that the weight of a man may be suspended from such a wire without breaking it. While therefore the attraction of gravity, when exerted by such accumulations of matter as the sun, or even the earth, is very powerful, between masses of small size, situated at great distances from each other, it is almost imperceptible.

It is not too much to say that two masses of the size of the largest meteorite that ever descended to our earth, if placed on opposite sides of the orbit of Neptune, would not attract each other with a force sufficient to move the most delicate chemical balance; and during the first few millions of years, it is improbable that their rate of motion towards each other would be such as would be perceptible to the keenest human vision, aided by a powerful microscope. But that they *would* tend towards each other with gradually-increasing velocity, does not admit of doubt; and after a period of time of sufficient length, they would approach each other with a velocity greatly exceeding that of the swiftest cannon ball.

An important question now suggests itself. Would the light resulting from the gradual condensation and falling together of these masses begin to illuminate the heavens before the light produced by the union of the elements under the influence of cohesion and chemical affinity had entirely died away?

At first, as we have just remarked, the motion of these small masses or atoms towards a common centre, would be

very slow. No definite centre* marked by a powerful attracting mass, would exist, and not until the contents of a space probably as large as the present solar system had been concentrated together, would any great light or heat have been produced. In making this estimate we are guided by general considerations in regard to the probable amount of matter existing in a definite space. If we suppose our sun and solar system to be a fair example of the numerous other systems which surround us, we must conclude that the proportion of matter to space originally existing in a nebular form was exceedingly small. The nearest fixed star is not less than 20,000,000,000 miles distant. Suppose for an instant that our sun, with its attendant planets, were suddenly resolved into vapor, and made to fill equably a sphere of this diameter. Such calculations as we have been able to make, lead us to conclude that the atmosphere created by such a process would not exceed in density the vacuum produced by a good ordinary air-pump.

Consider then, if you will, the incredibly slight force which would tend to collect the atoms or small compound masses throughout this space. Millions of years would probably elapse before the formation of a nucleus containing as much matter as exists in the little planet Hestia, on which a ton of matter would weigh but a few pounds, and upon whose surface a mass of iron would fall with a shock scarcely perceptible.

And during this period, instead of each small meteorite rushing with lightning-like velocity to its destination, and glowing with fierce heat from atmospheric resistance, it

*A central mass would not be necessary for the mere attracting of the distant masses. The common centre of gravity of the whole would probably be sufficiently definite to effect this. But a central nucleus would be necessary for the conversion of the motion of these small masses into light and heat.

would pass through a comparative vacuum, and would finally fall on the attracting mass more like a downy feather on the placid surface of a lake, than like the fierce plunge of a solid body against a sun or planet.

No person of sound judgment can consider all the circumstances attending the first aggregation of matter, without perceiving that the process must have been an exceedingly slow one. Millions and millions of years must have passed away before the accumulations round any central point of attraction could contain as much matter as exists in our own sun; and long ere this the primeval fires must have died of sheer exhaustion, the small meteoric masses produced by the first combustion must have cooled, darkness—even the blackness of ashes—wrapped the universe in its gloom, and the first day came to a close.

Who dares to assert that that day was one of 24 hours? That twelve hours bounded the night which brooded over the face of creation from the beginning, when God called the heavens and the earth into being, until that morning when he said, "Let there be light, and there was light."

Who shall dare to say that that light which produced the first day, and which illumined the universe when as yet there was neither sun, moon nor stars, was bounded in its duration by 12 hours, or 24 hours, or 24 millions of years? God does not so bound it. He tells us that it was a period of darkness, and a period of light, and that he was pleased to give it the same name that we apply to similar alternations of light and darkness on our globe. But as to its duration, nothing whatever is said.

It is not impossible that the time may come when we shall be able to determine its duration with as great accuracy as we are able to determine any other large quantity. We have weighed some of the stars in balances, measured their

distances, and obtained a clue to their chemical composition. And the time may perhaps arrive when all the data necessary for determining the length of the first day shall be within our reach. But not yet.

And now night has again wrapped the universe in its embrace; and darkness, but not inaction, has fallen over all. Still that distant centre continues to attract the floating masses. The nearer ones fall into it, increase its bulk and add to its power. Gradually through that long night it enlarges, until at length the falling meteors no longer glide gently to its surface. Across untold distances it attracts the quiescent masses, and draws them towards it by a subtle chain. Gently and almost imperceptibly they move at first, but gradually their velocity increases, and at length they dash against the central mass with a force which gives rise to light and heat, and lo! a faint star rises on the gloom, and day again begins to dawn!

But faster and faster these falling masses come. The faint speck of light is becoming a sun, and at length, after a period of whose length we can form but a faint idea, it glows with a light, compared with which the beams of our sun are but as twilight—and the second day, with its prospective work, is fully ushered in.

And here an interesting question arises: Would the morning light of this day be produced by one sun, or by several? Or in other words, would there be one great centre of attraction for all these masses, or would there be many?

It is true that this question does not materially affect the value of our general deductions, but it is a point which possesses features of deep interest. We confess that we incline to the belief that all the matter which now constitutes the sun and moon and stars, as well as our own

earth, was at one time collected together in one central sphere—that central sphere being probably the great central sun around which recent astronomical discoveries indicate that our solar system is revolving. Our grounds for this supposition are these :

If the existing matter had primarily fallen towards two or more grand centres, what was there to prevent these centres from falling together ? In the case of our solar system we know that the earth and planets are kept from falling together by centrifugal force, which opposes the action of gravity and balances the system as a whole. But here let us state for the benefit of the non-scientific reader that this centrifugal force is not one of the natural forces, like gravity or cohesion, but is dependent for its existence upon that tendency which all bodies have to *continue* in motion in straight lines. The centrifugal force which keeps the planets at a distance from the sun has its origin in the motion which was first produced by the action of gravity, and we cannot conceive of any mutual dependence and balance existing between bodies which were not, in the first instance, connected as are our own sun and its planets.

We regard it, therefore, as almost certain that our sun bears the same relation to some more distant centre that the earth does to the sun, and the moon to the earth. Nay, it is not impossible that instead of our being in a secondary or tertiary system, there may be many systems above us ; that our sun is but a planet in the great starry system which surrounds us, and that even this starry system itself is but one of many systems of suns, which, with their planets and satellites, revolve round some more distant centre.

A study of the physical laws which govern the universe teaches us that unless the original nebulous matter was

equally diffused through space, this central sun would, from the very nature of its origin, acquire a rotatory motion on its axis. This motion would become more rapid as the mass acquired a greater degree of concentration, and at last the velocity would become so great that the centrifugal force of the exterior portion of the mass would balance the tendency to fall towards the centre; a ring would consequently form round the equatorial belt, and, at length, a sun or a star would be separated from the primal mass. This sun or star would remain in space, but, as the distance between it and the parent mass became greater in consequence of the contraction of the latter, it would fly off further, and would, at the same time, revolve on its own axis while it continued to revolve in an orbit a little larger than the size of the original ring. As it cooled, the rapidity of its axial rotation would increase, until at last, it, too, would give off secondary suns or stars, while the first or parent mass would still continue to give off other suns, which would bear the same relation to the globe first given off that Saturn and the other planets bear to Neptune. And so in descending series the process would go on. As previously stated, it is impossible for us to tell in which of all these series we are found. That our sun revolves around some distant centre, recent investigations have placed beyond all doubt, and, if this be so, then unquestionably there are other bodies of the same character as our sun, pursuing a similar journey. And it is not at all impossible that the centre around which we revolve is but a secondary or tertiary sun in the grand scheme of the universe; that the system of stars which each night unfolds to our view, is but one system amongst many others, which through countless ages have pursued their silent course around that great primal sun, whose beams constituted the source of light of the second day.

In process of time our sun would be thrown off; after a further period the superior planets would be formed, and finally our earth would be separated or divided from the parent mass of our solar system. If now we bear in mind that the sun at this time probably extended as a fluid or gaseous mass up to or beyond the bounds of the earth's orbit; that when first formed the earth was probably a fluid mass, which extended far beyond the orbit of the moon, and that it was by the separation of these fluid masses from each other that the heavens, as known to us, were constituted, we shall find no difficulty in seeing that the description of this process as given in Genesis I: 6, 7, 8, is as accurate as the imperfect nature of the Hebrew language would allow.

"And God said, let there be a firmament in the midst of the waters, and let it divide the waters from the waters.

And God made the firmament, and divided the waters which were under the firmament from the waters which were above the firmament: and it was so.

And God called the firmament Heaven, and the evening and the morning were the second day."

We must remember, in the first place, that it is not probable that Moses originated the word here translated firmament; but that he probably adopted the word which was in use amongst the Hebrews to denote the region in which the stars are placed.

Bear in mind also, that the language in which Moses wrote had no equivalent to our word "air" or "atmosphere."

"The Hebrew language has no word for air, properly speaking, because they knew not the thing. Their nearest approaches were with words that denoted watery vapour condensed and thus rendered visible, whether floating around them or seen in the breathing of animals; and words for

smoke arising from substances burning ; and for air in motion, wind, a zephyr whisper, or a storm. But of elastic fluids they had no idea."—J. PYE SMITH.

Remember also that the Hebrews had no terms for the abstract ideas which we express by "fluid" or "matter." If Moses had designed to express the idea—"In the beginning God created *matter*," he could not have found words to serve his purpose.

Bearing in mind, then, these imperfections of language, and making due allowance for the use of ordinary colloquial expressions, which, though really inaccurate, are found both in Scripture, and in common use by scientific men, we find no difficulty in understanding the description given by Moses of the second day's work.

It is scientifically certain that the material which was *divided* was the *fluid* matter of the great central sun and of our own luminary. By their division, and by placing the "concave vault" of heaven between the earth and the stars and their parent globe ; between the *fluid* above the firmament and the *fluid* below it, the solar system was formed and the firmament created.

Nor is the *firmament* which holds the sun and the stars in their places the flimsy affair which some scoffing critics would have us believe it to be. Solid brass and adamantine rocks are not more firm than those foundations which He laid of old for the earth, that it should not be moved ; and that mysterious chain which links sun and earth together, is not the less strong because eye hath not seen it, nor sense of touch felt it, nor hath it entered into the heart of man to conceive what it is.

The idea that by the firmament is here meant the atmosphere which divides between the clouds and the ocean, is too obviously absurd to need refutation—"And God called

the firmament Heaven." We have stood on a mountain side and seen the storm clouds rolling beneath our feet, while yet lower down lay the blue expanse of ocean. Had we passed *through Heaven*, and ascended above it? And would any Hebrew have so understood the words of Moses as to suppose that we had?

Beyond all question the ordaining of the firmament was the arranging of the starry and planetary spheres in the relations which they now sustain to each other—the creation of what we would understand by the word Heaven.

And that this was the work of the second day—the second period of light—both science and revelation most distinctly assert. During the first portion of that long day the beams of the great central sun illumined the universe. As fast as it cooled fresh suns were separated from it, and from these, others, until in the order of creation our earth was formed.

And now this new formed earth rolls round its parent sun a fiery, molten mass. At length the moon is separated from it, but neither sun nor moon as yet *govern* night or day, for the earth itself is luminous, and on every part of its glowing surface a lurid, self-evolved light is maintained. Of neither the sun nor the moon do we hear anything until the fourth day, when they are set "for signs, and for seasons, and for days, and for years."

CHAPTER VII.

Third Day. The Primeval Atmosphere.

That up to this time there would be no need of the light of the sun and moon is quite in accordance with the results of modern research, for it is a general belief amongst scientific men that the temperature of the earth was at one time sufficiently high to produce fusion of the entire mass. The grounds upon which this opinion is based have been well stated by Prof. Dana in his Manual of Geology.

"Ascertaining through astronomy that the sun of our system is in intense ignition; that the moon, the earth's satellite, was once a globe of fire, but is now cooled and covered with extinct craters, and that space is filled with burning suns; and learning also from physical science that all heated bodies in space must have been losing heat through past time—the smallest most rapidly—we safely conclude that the earth has passed through a stage of igneous fluidity.'

If this be true, it follows that during this period the atmosphere of our planet must have presented a constitution, and produced effects very different from those exhibited by the air we breathe.

It is to be presumed that so far as kind and quantity of matter is concerned, the earth, as a whole, is the same now that it ever was—that nothing has been added and nothing taken away. The constituents of the present atmosphere undoubtedly accompanied the earth on its first journey

round the sun; and the only difference between the present atmosphere and that of the primeval world, consists in the large additions of volatile matter, which would be caused by an increase of temperature.

The chemical combinations, and consequently the physical forms in which the various elements composing the earth and its atmosphere would exist, would depend largely upon temperature, and upon the proportion in which the several elements might be present.

Assuming a temperature equal to a full red heat, the following would probably be the conditions in which the more important elements now forming the earth would be found:

Carbon.—Nearly all the free carbon found in the earth shows signs of having, at no very distant day (speaking cosmogonically), formed part of the tissues of living vegetables; and the laws of vegetable life teach us that before it could reach this point it must have existed as carbonic acid.* But aside from the evidence thus afforded, we know that at the temperature named the carbon would have taken oxygen from the air, from almost all metals, from sulphates and from water, until it had been entirely converted into carbonic acid. We may therefore set it down as certain that all the carbon which now exists in coal, in living and fossil animals, and in living vegetables, existed at this time as carbonic acid.

Oxygen.—So long as any free carbon, free sulphur, free hydrogen, oxidable metal or sulphides existed, no oxygen would be found in the free state at the temperature we have indicated. Hence the proportion of carbon, &c. existing in the earth becomes an interesting question, as it at present

* As this work is designed for the use of that ill-defined individual known as "the popular reader," we have not deemed it best to introduce the new chemical nomenclature. Carbonic anhydride is still best known by the name of carbonic acid, and argentic nitrate by that of nitrate of silver.

forms the great bulk of deoxidating material. We are inclined to believe that the carbon alone now existing in the earth is sufficient to convert all the oxygen of the air into carbonic acid, and leave a large surplus for the deoxidation of the sulphates and metallic oxides. We base this estimate on the following data:

The coal area in North America alone is estimated to cover 310,500 square miles, and the aggregate thickness of the layers varies from 8 to 120 feet. If we take a mean of 60 feet, which we think is not far out of the way, the calculation will be as follows:

Taking Newcastle coal as the standard (Pennsylvania anthracite would give results more in favor of our hypothesis) we find that a cubic foot weighs 79 lbs., and 100 lbs. of such coal consists of—

Carbon,	83.274
Hydrogen,	5.171
Oxygen and Nitrogen,	9.036
Ashes,	2.519

Allowing the oxygen to form eight parts, this would cancel one part of the hydrogen, and we then have four parts of hydrogen left uncombined.

The amount of oxygen required to saturate such a mass would be as follows:

Carbon, $\frac{83.274 \times 16}{6}$ = 222 lbs. oxygen.
Hydrogen, $\frac{4 \times 8}{1}$ = 32 " "

100 lbs. of Coal, requiring 254 lbs. of oxygen for their perfect combustion.

Now the air resting on each square foot of the earth's surface is equal to 2,121 lbs. Of this, one-fifth, or 424 lbs., is oxygen. Hence 157 lbs. of Newcastle coal would convert into carbonic acid and water all the air resting upon a square

foot. This amount of coal is contained in rather less than two cubic feet. Hence each square foot of a bed of coal 60 feet thick, would convert into carbonic acid and water all the air standing on 30 square feet; and the coal in North America alone would saturate all the air that rests on 9,315,000 square miles.

But the surface of the North American continent is computed to be equal to 8,080,000 square miles. Hence the coal beds which are known to exist beneath its surface would be amply sufficient to convert into carbonic acid and water all the oxygen which rests upon it.

When we transfer our investigations to other continents, we meet substantially the same results. In some cases, as in the west of England and South Wales, the coal beds attain a vastly greater magnitude—being estimated at an aggregate thickness of 200 to 300 feet, distributed amongst 100 seams, which are interspersed amongst 10,000 to 12,000 feet of coal-bearing strata. Some coal basins which are disposed amongst the secondary formations in the centre and south of France, present beds less numerous, but thicker, and less regularly stratified. The two basins of the Saone and Loire, the principal mines of which are Creuzat, Blauzy, Montchanin and Epinac, contain only ten beds; but some of these attain 100, and even 120 feet in thickness, as at Montchanin.

It must be remembered that in all this we speak only of the *ascertained* extent of these coal fields. In addition to this, we have the published opinion of Sir R. Murchison, that the whole of the Permian series of rocks have for their floor coal fields more or less extensive.

When, therefore, we consider further that it is far from probable that we have discovered more than a very small per centage of all the coal that exists in the earth; and

still further, that the ocean probably covers as great a proportionate amount of coal as the land; when we further take into consideration the carbon and hydrogen of all the petroleum, of all the living forests and plants, together with the amount that exists in the soil as roots and humus, all the peat beds, all the animals, marine and terrestrial, and all the marine vegetables, the amount of carbon and hydrogen available for the purpose indicated is enormous. Such calculations as we have been able to make, lead us to believe that it is far in excess of that required to saturate all the oxygen of the air; and, indeed, that after this had been effected, a balance would remain sufficiently large to deoxidate all the sulphates, and many of the oxides.

SULPHUR.—Sulphur exists at present in a free state, though probably not in very large quantities; the great bulk of the sulphur which enters into the composition of the globe being found in combination as sulphates and sulphides. It is more than probable that at the period under consideration the sulphur existed in combination with various metals as sulphides.

CHLORINE undoubtedly existed as chloride and chiefly in combination with calcium. This salt is perfectly fixed at a temperature much higher than that to which we suppose it to have been subjected, and there is undoubtedly calcium enough now existing as carbonate of lime to saturate all the chlorine in existence.

SILICA probably existed in combination with earths and alkalies, but to a greater extent than it does now. It may be safely assumed that all the free silica now in existence, would be absorbed by the potash, soda and lime which under the conditions we have named would have combined with it instead of uniting with carbonic acid. Sulphate of lime, which forms such a large proportion of the rock crust of the

earth, is readily decomposed by silica when the temperature becomes elevated—silicate of lime, sulphurous acid, and oxygen, being the products of the chemical changes involved.

A consideration of these facts would lead us to believe that at the period to which we refer, the atmosphere contained the following constituents:

1st. All the nitrogen and carbonic acid now found there.

2nd. All the oxygen now found in the atmosphere, but converted into carbonic acid.

3rd. All the carbonic acid which would be produced by the deoxidation of the oxides and sulphates by the surplus carbon.

4th. All the carbonic acid now existing as carbonate of lime, &c. Carbonate of lime could not exist at a temperature much higher than that described, and we must remember that the earth was then cooling, and that the temperature previously existing was much higher. The amount of gas derived from this source would be very large. Each cubic foot of marble contains about 72 lbs. of carbonic acid. The gas existing in a bed of pure marble 30 feet thick, would double the amount of the atmosphere resting on it.

5th. All the water existing in the ocean, rivers and lakes; all the moisture existing in the earth and which is always found on digging deeply; all the water arising from the combustion of the hydrogen found in coal, petroleum, plants, animals, &c. To this must be added all the water found in combination with minerals. In this form, water is much more universally diffused than those who have not studied the subject are apt to suppose. Even hard Basaltic rocks contain four per cent. of their weight of water. Clay, which to the ordinary observer appears perfectly dry, contains from 6 to 16 per cent. of water. If we allow 10 per cent. for the average proportion of water in clay, a bed of clay 140 feet deep

would contain an amount of water sufficient to double the weight of our atmosphere if it were converted into vapor.

6th. All the nitrogen existing in combination in animals and vegetables.

A recent writer on Geological subjects, M. Figuier, denies that at this period the atmosphere was any richer in carbonic acid than it is to-day. In his work, "The World before the Deluge," he says: "Seeing the enormous mass of vegetation which then covered the globe, extending from one pole to the other; considering also the great proportion of carbon and hydrogen which exists in the bituminous matter of coal, it has been thought, and not without reason, that the atmosphere of the period would be richer in carbonic acid than the atmosphere of our days. It has even been thought that the great proportion of carbonic acid gas in the atmosphere was an explanation of the small number of animals, especially aerians, which then lived. This, however, is pure deduction, totally deficient in proof. Nothing proves that the atmosphere of the period was richer in carbonic acid than the atmosphere of our days."

And yet Mr. Figuier believes that the earth had just cooled from a state of incandescence! Certainly no chemist would for an instant entertain the idea that the oxygen and carbon which now exist could be brought together at the temperature he mentions without entering into combination. And if once combined, by what power could they be separated? Only by the growth of plants which thus served to prepare the way for the advent of animals, and after having performed their allotted task, were consigned to the depths of the ocean, there to await the requirements of a still higher order of beings.

If we adopt the views which we have here advocated, it is obvious that the primeval atmosphere must have consisted chiefly of carbonic acid, watery vapor, and nitrogen, the

small quantity of vapor of mercury and volatile salts not being worth consideration.

For a long time subsequent to the formation of solid matter on the surface of the earth, this atmosphere would remain clear and comparatively transparent, or, at most, it would be but slightly obscured by precipitated clouds of the more volatile salts, and it would unquestionably remain in this condition just as long as the temperature of the earth was sufficiently high to maintain in the form of permanent gas the watery vapor of which it chiefly consisted. Although this temperature would be vastly greater than 212° owing to the enormously increased atmospheric pressure, yet it may have been far below the fusing point of most solids.

It is, of course, impossible to make anything like an accurate calculation of the extent of this atmosphere and of its barometric pressure, but the following is believed to be an approximation to the truth.

Constituents of the Primitive Atmosphere.	*Inches of Mercury.*
Present atmosphere	30
Water of the ocean, lakes and rivers—average depth of ocean assumed to be about four miles, which is equivalent to an average depth over the surface of the earth of three miles	14,079
Water mechanically interspersed through the earth and found on digging wells and sinking the deepest mines—not less than half a mile	2,346
Water which is now chemically combined with the minerals forming the crust of the earth, but which would be driven off at the temperature we have assumed—say four per cent. of the earth's crust—one mile	4,693
Carbonic acid produced by the saturation of the oxygen of the air, an additional	2¼
Carbonic acid produced by the oxygen of the oxides, sulphates, &c., probably not less than	5
Carbonic acid from the carbonate of lime, magnesia, &c., existing as limestone, coral and shells.*	1,000
Height in inches of the barometric column equivalent to the primeval atmosphere	22,155¼

*As previously remarked, the amount of carbonic acid now locked up

In other words the mercurial barometer instead of standing at a height of 30 inches, stood at a height of over one third of a mile. It has even been estimated by M. Figuier and others that at this time the atmosphere extended to the moon, in which case if we represented the space occupied by such an atmosphere by a circle small enough to be contained on this page, the earth would appear of a diameter equal to the tenth of an inch. But this extended atmosphere must not be confounded with that nebulous condition in which much of the matter forming the earth existed at the time the ring, which ultimately contracted into the moon, separated from its parent globe.

Under such circumstances, a pump, instead of refusing to draw water from a depth of over 34 feet, would have worked even if the well had been over four miles deep, and each square inch instead of supporting a pressure of fifteen pounds was subjected to one of over 11,000 lbs! A boy's sucker, 3 inches in diameter, would have been able to lift a rock weighing 35 tons! The little brackets furnished with ad-

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in this way is very large. Thus Dana gives the thickness of the limestone beds found in the Appalachian range, as follows:

		Limestones.
1	Potsdam periods.....	200 feet.
2	Rest of Lower Silurian.....6,000	"
3	Lower Silurian era.....6,200	"
4	Upper Silurian era..... 600	"
5	Devonian Age..... 100	"
6	Carboniferous Age..... 125	"
	Total thickness,	13,225 feet.

Beds of chalk, 500 feet thick, and extending over considerable areas; mountains of compact limestone, marble, and other forms of carbonate; enormous beds of shells, marl, &c., together with the considerable percentage of carbonate of lime found in many soils, altogether make an aggregate which leaves no doubt that the amount of gas derived from this source is not over estimated at one thousand inches of mercury.

hesive suckers which we attach to walls, &c., for temporary supports, would have adhered so that the power of ten strong men could not have removed one of them. Some kinds of insects and toads possess suckers whereby they can cling to objects and support themselves against the action of gravity. If the feet of a man of 150 lbs. had been furnished with similar suckers for a similar purpose, these suckers need not have been more than one-fourth of an inch in diameter to have enabled him to walk head-down on a ceiling. It is well known that on some of the high mountains of the globe, eggs cannot be boiled because the pressure of the air is so far diminished that the boiling point of water is lower than the *cooking* point of eggs. In the primeval atmosphere, the eggs would have been reduced to charcoal long before the water had boiled.

With such pressures and temperatures it is difficult to calculate how far the rays of light would be absorbed in passing through the atmosphere ; but it is certain that at an early stage of the process of cooling, the sun's rays would be entirely obstructed, and Cimmerian darkness would envelope the earth. And not until the greater part of the vast amount of water which we have described had been precipitated in the form of rain, would day have again dawned.

Slowly, then, but steadily, the process of cooling would go on. The amount of heat radiated by the earth would be no longer able to retain the superincumbent watery vapor in a gaseous state. Clouds would begin to form, and gradually, but surely, night would descend upon our globe. Not a night limited by a semi-rotation of the earth upon its axis, but a night whose reign endured for thousands of years. The earth might revolve and present its varying surface to the sun, but no ray of light could penetrate the dense gloom in which it was enwrapped.

Let us consider for a moment how intense and complete was the darkness of this night.

We have all seen the sun's face darkened by thunder-clouds, when their black masses were driven by fierce tempests across his disc. From the cheerful light of day the change to intense gloom was rapid. The birds sought the densest shade, the wild beasts fled to their lairs, and men's faces grew pale as they gazed upon nature and upon each other. And yet all this was produced by clouds representing at most but a few inches of water.

Again, we have seen a light, fleecy cloud of vapor floating away on a still day from a passing locomotive, and throwing down its shadow upon the green fields—a shadow black as ink. And yet, if all the water in this tiny cloud had been precipitated on the meadow over which it passed, it would not have deposited on the darkened area a depth of water equal to the tenth of an inch.

What then must have been the darkness of that night, when the clouds—which wrapped the earth as with a swaddling band—contained water sufficient to have covered the whole surface of the earth to the depth of from four to five miles?

As the process of cooling gradually advances, the enormous atmosphere which we have described—an atmosphere to be measured in yards of mercury instead of inches—gradually precipitates its moisture on the earth in the form of rain. And what a fearful rain was that! Noah's deluge was but as a summer shower compared with the torrents of that awful night. Year after year, century after century, the rain fell down in floods, and ever and anon, as it touched some heated spot on the earth's surface, or found its way into some crevice, it passed back again to the clouds with explosive violence. Moreover, the surface of the earth would,

by such sudden cooling, be distorted and riven into still greater chasms. Into these, the boiling waters of this primeval deluge would be poured, but only to aggravate the mischief; so that who can tell the duration of that long period of darkness, during which, the oceans that now are, were distilled and re-distilled as in a huge alembic. And yet, puny man, with his false interpretations, would limit the duration of this night to 12 hours!

But at length a period arrives, when the waters, instead of being constantly returned to the clouds, whence they came, remain in quiet on the surface of the earth. And as cloud after cloud discharges its watery burden, the ocean rises until it covers the entire face of the globe. During this long period it was one continuous rain, and every hill-side was washed by constant torrents of a volume and velocity of which we have no conception.

No hills could withstand such a deluge as that. No continent could resist the denuding action of such fearful floods. The results of former upheavals would be worn down and when the last shower had fallen, and the sun's rays once more lit up the surface of this planet, it is more than probable that the morning of that day rose upon one unbroken expanse of water.

And now the question arises: If the sun is the source of light for that third day, why was it not a day of 24 hours? Moses tells us that the sun was not yet set for signs, and for seasons, and for days, and for years; and science equally declares that, during the long ages of that third day, the sun never rose or set, but, like Joshua's sun on Gibeon, he hasted not to go down until the creative work was finished.

As this is not only a novel, but no doubt a rather startling proposition, we propose to lay the proof of it somewhat fully before our readers.

Every boy knows, that when a stick is thrust into water in a slanting direction, it appears broken or bent, and the explanation of this will be found in any school philosophy.

In the same manner, if we place a coin in a basin and stand in such a position that the edge of the basin just hides the coin from view, on pouring water into the basin, the coin will become visible. In fact, the coin will seem to be raised—a phenomenon due to the bending which the rays of light sustain on passing out of the water.

Now, the same cause that rendered the coin visible when the vessel was filled with water, causes the sun to be visible to us after he has, in reality, descended beneath the horizon.

To such an extent does this obtain, that, when the lower edge of the sun has touched the horizon, his whole disc has, in reality, passed below it and would be entirely out of sight and concealed by the convexity of the earth, but for the bending round it which the rays of light have undergone in their passage through the air.

"But, even after the sun has set, the influence of the atmosphere still continues to send us a portion of his light; not, indeed, by direct transmission, but by reflection upon the vapors, and minute solid particles which float in it, and perhaps, also, on the actual material atoms of the air itself. To understand how this takes place we must recollect that it is not only by the direct light of a luminous object that we see, but that whatever portion of its light which would not otherwise reach our eyes is intercepted in its course and thrown back, or laterally, upon us, becomes to us a means of illumination. Such reflective obstacles always exist floating in the air. The whole course of a sunbeam, penetrating through the chink of a window-shutter, into a dark room, is visible as a bright line in the air; and even if it be stifled, or let out through an opposite crevice, the light scattered

through the apartment from this source, is sufficient to prevent entire darkness in the room. The luminous lines occasionally seen in the air, in a sky full of partially broken clouds, which the vulgar term "the sun drawing water," are similarly caused. They are sunbeams through apertures in clouds, partially intercepted and reflected on the dust and vapors of the air below. Thus it is with those solar rays, which, after the sun itself is concealed by the convexity of the earth, continue to traverse the higher regions of the atmosphere above our heads, and pass through and out of it without directly striking upon the earth at all. Some portion of them is intercepted and reflected by the floating particles above mentioned, and thrown back, or laterally, so as to reach us, and afford us that secondary illumination, which is twilight."—*Herschell.*

In northern latitudes, these and other causes conspire to render a portion of the year a continuous daylight, and this, too, in localities where the sun is not constantly above the horizon. Hence in almanacs calculated for the northern parts of Great Britain, there will be found a long series of days against which is noted "No real night at this time." And we ourselves have read fine print at midnight in the Scottish capital.

Nothing strikes the stranger more forcibly, if he visits Sweden at the season of the year when the days are longest, than the absence of the night. Dr. Baird relates some interesting facts. He arrived at Stockholm from Gottenburg, four hundred miles distant, in the morning, and in the afternoon went to see some friends. He returned about midnight, when it was as light as it is England an hour before sunset. You can see distinctly, but all was quiet in the streets; it seemed as if the inhabitants had gone away or were dead. The sun in June goes down in Stockholm a

little before ten o'clock. There is great illumination all night, as the sun passes round the earth toward the north pole, and the refraction of its rays is such that you can see to read at midnight without any artificial light. The first morning Dr. Baird awoke in Stockholm he was surprised to see the sun shining in the room. He looked at his watch and found it only three o'clock. The next time he awoke it was five o'clock; but there were persons in the streets.

There is a mountain at the head of Bothnia where on the 21st of June the sun does not appear to go down at all. The steamboat goes up from Stockholm for the purpose of conveying those who are curious to witness the phenomenon. It occurs only one night. The sun reaches the horizon, you can see the whole face of it, and in five minutes more it begins to rise. At the North Cape, latitude 72 degrees, the sun does not go down for several weeks. In June it would be about 25 degrees above the horizon at midnight. In the winter-time the sun disappears and is not seen for weeks; then it comes and remains for ten or fifteen minutes, after which it descends, and after a time it does not set at all, but makes almost a circle round the heavens. Dr. Baird was asked how they managed in those latitudes with hired persons, and what they considered a day. He replied that they worked by the hour, and twelve hours was considered a day's work. Birds and animals take their accustomed rest at the usual hour, whether the sun goes down or not.

Let us now consider the very small extent of atmosphere which is sufficient to effect all this.

The height of our present atmosphere is generally estimated at 50 miles, and whatever objections may be urged against this height as a limit, there is no doubt of the fact that at a height of fifty miles the atmosphere is so rare that it does not equal in density the air which is found in the exhausted receivers of our best common air pumps.

The diameter of the earth is in round numbers 8,000 miles, and 50 miles is the $\frac{1}{160}$ part of this. If, therefore, we were to represent the earth by a globe one inch in diameter, the atmosphere would form around it an envelope about as thick as a sheet of writing paper.

But the atmosphere which on the third day still remained around the earth, must have been of much greater extent. In addition to the material of the present atmosphere there would remain all the carbonic acid and other gases which we have described, and these gases, at the resulting pressure and existing temperature, would retain a very large amount of water, in the condition of invisible vapor, so that a barometric pressure of 1,200 inches, or 40 atmospheres is nothing extravagant or impossible.

The effect which would be produced by an atmosphere of forty times greater extent would be vastly greater in proportion, because not only would the rays throughout a much greater range of space be deflected, but each ray would be deflected to a greater extent. Hence it is not at all improbable that a soft yet brilliant twilight was never absent from any portion of the earth's surface. On certain parts of the earth the sun disappeared but for a few minutes, and it is not impossible that for a short portion of the year two suns were visible in Scotland and Canada, one rising in the east before the other had set in the west.

In perusing the account of the creation given in the first chapter of Genesis, it must strike every attentive reader that while the entire second day is devoted to the ordaining or creation of the firmament, the third day has crowded into it not only the gathering together of the waters, but the creation of the vegetable kingdom. We think that an ordinarily speculative character would have placed the creation of the firmament and the gathering of the waters together, and

left the plants to the fourth day. But Moses followed the truth too closely.

We have previously stated that when the third day dawned upon our earth the sun's rays fell upon an unbroken expanse of ocean. But such a state of things could not long continue. The earth's solid crust was still comparatively thin; the evaporation of that vast layer of water would cool it rapidly; its contraction could hardly be supposed to proceed equably, and upheavals of great extent would be the result. It is doubtful if at this time any of our present mountain ranges were elevated. It is quite possible that even the oldest mountains are of much more recent origin. However this may be, it is certain that dry land would soon make its appearance, and the seas be gathered together in one place.

Plants now appear upon the surface of the earth, and grow apace. Gigantic ferns and monstrous palms clothe the newly elevated land. In that hot and moist air they grow to maturity and sink to decay with astonishing rapidity.

At last the atmosphere is so far purified and diminished that day becomes no longer a continuous visible presence of the sun, but merely an illumination of the globe, similar to that previously mentioned, as occurring in Scotland in midsummer. True it is still constant day, but day subject to changes of brilliancy, according as the sun poured his direct rays on the earth's surface, or illuminated it by a brilliant yet soft twilight.

We have already had occasion to note that it is probable that the several days differed greatly in brightness, and it is probable that the same is true in regard to the nights. The light of the first day was unquestionably the most universally diffused, and, on the whole, the most brilliant, if we

regard the general illumination. But the light of the vast central sun, of the second day, no doubt far exceeded it in its own immediate vicinity. The brilliancy of that day will probably be equalled only when the "Heavens shall pass away with a great noise and the elements shall melt with fervent heat," and a new Heavens and a new earth shall appear.

But after the earth had been separated from the sun, and while it depended upon its own luminosity for daylight it is probable that the day was anything but brilliant. Still it was day. No distinction is made in the sacred record, and none can be made by science. Dull winter days, shrouded in clouds and mist, are *days* as well as the brightest of the sunny hours of summer.

The third day was probably far inferior in brilliancy to our days. The heavy and often murky atmosphere would make it dull, and it would be at length entirely obscured by a phenomenon different from anything that has yet entered into our consideration.

CHAPTER VIII.

The Fourth Day.

On this day the sun and moon were ordained as regulators of night and day, being appointed "to divide the day from the night" and "to be for signs, and for seasons, and for days, and for years." From this time forward, therefore, not only is the sun the great source of light to the earth, but it is the obscuration of his rays, by whatever means effected, that regulates day and night. The darkness of the first, second, and third evenings was not produced by the darkening of the sun, or the shutting out of his rays. On the first and second evenings he did not exist, and it was the cooling of the earth itself, not the mere absence of sunlight, that produced the third period of darkness. So that the obscuration that preceded the fourth day—that is the evening of the fourth day, was the first period which exhibited the governing agency of the sun. But from this night onward it is the varying relations of the sun to the earth that produce and regulate the alterations of day and night.

The darkness which preceded the fourth day was probably produced by the rapid evaporation of water introduced into the highly heated interior of the earth by extensive earthquakes. However much some eminent geologists may be opposed to the idea that such agencies as earthquakes, rains, &c., once acted with far greater intensity than they do at

present, we have no doubt that such was the case, and we can scarcely believe that matters settled down into the quiet which now reigns without one or more fearful convulsions. The night which would be the result of these causes was most probably of short duration. The vapor produced in the way which we have described would be precipitated in the course of a few years and light would again enliven the face of the earth, while the descent of such large quantities of water at a comparatively low temperature would tend powerfully to wash and purify the air and fit it for the inhabitants which were to be introduced on the fifth day.

CHAPTER IX.

The Fifth and Sixth Days.

Thus far we have trod on the firm ground of well ascertained facts. That the chemical and physical forces now in operation would produce the results we have indicated is known as certainly as any facts in science, and we might, without impropriety, rest here and take our stand upon the ground that a narrative which has been found strictly accurate for the first four days would probably be found correct for the remaining two. An efficient cause of the alternation of light and darkness during two further periods, might be found in various cosmical changes that might occur, such as the evolution of vapor produced by the access of water to the internal fires, &c. But the most probable cause is found in the influence produced upon the sun itself by the giving off of the inferior planets, Venus and Mercury. During the periods immediately preceding and succeeding each of these events there would be a succession of darkness and light and thus we would have two more days added to the number.

That this would in all probability be the case, a very slight consideration of the subject will show. At the time that the earth was separated, the matter composing the sun must have occupied a space nearly as large as the present orbit of our planet, and for a long period prior

to the separation of Venus there would be daylight —not very brilliant it is true, but still daylight. For we must remember that owing to the enormous surface at this time presented by the sun, the *quantity* of heat and light emitted would be very much greater than at the present rate while the *intensity* would be greatly less. The light would therefore be feeble at first but would become more intense as the sun gradually contracted, for it is a well known fact that a very small amount of condensation on the part of the sun or the earth would suffice to raise enormously the temperature of either of these bodies. It has been calculated that a contraction to the extent of 1-1,000th of his diameter would cause such an elevation of the temperature of the sun as would suffice for several hundred years' expenditure of heat at his present rate of emission.

Professor Plateau has devised a beautiful experiment that affords a very striking illustration of some of the points connected with the formation of these rings and the ultimate formation of planets out of them. Unfortunately, however, this experiment has been adduced by pseudo-scientific lecturers and literary men, who have not studied it carefully, as a perfect illustration of the whole process of the formation of the planets. In this experiment the rings are *thrown off* by centrifugal force and the resulting planets revolve round the central axis at a distance considerably greater than that at which they were originally situated. It is obvious that no such result could ever occur in nature. The rings and planets are not *thrown off* by centrifugal force, but are separated by the contraction of the interior mass and are simply held in their places by centrifugal force. Consequently in the formation of the solar system the sun must at one time have filled the orbit of Neptune and gradually contracted leaving rings and ultimately planets at every step. As the interior

mass of the sun contracted and separated from the rings which afterwards formed the planet Venus, this ring would virtually form a cloud of vapor which would obscure the rays of the sun and prevent them from reaching the earth. Night would consequently settle over our planet and only when this ring had broken and contracted so as to form a spheroidal mass would day again dawn. After a time another ring would form, another cloud of condensed vapor would encircle the sun and obscure his rays, and another night would shroud the earth in comparative darkness, which would be dispelled only after Mercury had attained a separate existence. During the existence of these two rings, therefore, "the sun himself would grow dark," and night would descend over the solar system. Not a night of the intense darkness of the primeval night, when there did not exist a single source of light in the whole universe ; but a night which would be dark when compared with the previous days. The stars would shine as brightly as they do now, and the sun and moon would give off some light, although the latter would be quite faint. So that it is probable that there was sufficient light to maintain in a feeble way the processes of vegetation, and thus save alive many of the plants already created.

We must not forget that day and night—darkness and daylight—as known to us, are but comparative terms. We have no experience of that absolute darkness, that perfect night, which reigned before God said "Let there be light;" and as little are our senses able to convey to our minds any idea of the fullness of that light which burst upon the universe during the period immediately succeeding the giving forth of the Divine fiat.

At the same time the physical condition of the earth, and its relations to plant and animal life, would undergo a gradual

change. During the first of these two periods (the 5th day) the atmosphere would remain impure—highly charged with carbonic acid — so that no mammals could exist in it. But it is well known that fishes and reptiles can exist in an atmosphere of a purity far inferior to that required for what are called warm-blooded animals. Snakes will live for hours in a comparative vacuum; and we have kept both snakes and lizards for days in an atmosphere so highly charged with carbonic acid that it proved rapidly fatal to mice. It is not improbable, therefore, that during all this time the atmosphere maintained a refractive power sufficiently high to produce continuous daylight whenever the sun was in a condition to give off sufficient light. During the fifth day, then—that is, at and subsequent to the time Venus was formed—fish, reptiles and birds were called into existence; for *they* could live in such an atmosphere as then existed.

But the atmosphere grows gradually purer. The difference between the light of the sun at different periods of the 24 hours becomes greater, although, from the fact that during the early part of this day the bright portions of the 24 hours were duller and the dark portions brighter than at its close, the whole period would seem one continuous day. The high refractive power of the atmosphere would bring much of the light of the stars and moon as well as the light of the sun to the earth, and the brighter portions of the 24 hours would gradually become brighter as the substance of the sun contracted, and thus the days of 24 hours would become more marked.

At last the ring which is to form Mercury separates—a long night again settles down over the earth and when Mercury is formed and the sun at length illumines the morning of the sixth day, the atmosphere is so pure that cattle and creeping things, (beasts of pray that creep on their victims)

make their appearance. Towards the close man is called into being and the days become reduced to a uniform length of 24 hours, the length of this period being determined solely by the revolution of the earth on its axis. It must be borne in mind that this change would be gradual. It would be difficult to say where the long day ended and the short day began, but then it would be difficult to say precisely when our present days end and the nights begin.

In order to exhibit more fully the wonderful accordance between the account thus given by science and the record found in the first chapter of Genesis, we give on the opposite page a tabular synopsis of the system which we have just endeavored to explain.

The table gives 1st, the days in their order; 2d, the evening and morning, or darkness and light of each day, and the causes which produced that darkness and light; 3rd, the special work of each day as set forth in the Bible and in the records as given by science.

THE SIX DAYS OF CREATION.

Period.			*Work Done.*
First Day.	Evening	results from the primeval darkness existing from the beginning.	The creation of Light or the calling into activity of the physical forces.
	Morning	results from the chemical union and combustion of the elements.	
Second Day.	Evening	results from the cooling of the ashes of the great combustion.	The Creation of the firmament or the arrangement of the heavenly bodies and interstellar spaces.
	Morning	results from the light of the great Central Sun.	
Third Day.	Evening	results from the cooling of the earth and the deposition of dense clouds.	Elevation of the land, that is, the division of the land and water and the creation of plants.
	Morning	results from the clearing away of the clouds and the shining of the Sun, day being rendered continuous by the enormous refractive power of the primeval atmosphere.	
Fourth Day.	Evening	results from the obscuration of the Sun by vapor.	The ordaining of the sun and moon as governors of day and night.
	Morning	results from the precipitation of this vapor and the clearing of the atmosphere, the refractive power of the latter being still sufficiently powerful to produce continuous day.	
Fifth Day.	Evening	results from the separation of Venus from the Sun.	Creation of fishes, reptiles and birds.
	Morning	results from the restoration of the brilliancy of the Sun which still shines continuously.	
Sixth Day.	Evening	results from the separation of Mercury from the Sun.	Creation of mammals and man.
	Morning	results from the restoration of the Sun's brilliancy.	

CHAPTER X.

Where did Moses obtain his Knowledge of the Origin of the Earth?

It is not our purpose to enter into a full discussion of this question. We propose to consider merely one source whence he did *not* obtain it, and thus endeavor to reply to a certain class of writers who claim that whatever is true in the Mosaic cosmogony is merely such as would suggest itself to any well-informed mind, while the alleged errors and discrepancies are such as render it utterly unacceptable as a correct history of the Creation. These objections have been thus stated by Gliddon in his "Types of Mankind."

"The document JEHOVAH does not especially concern our present subject, and it is incomparable with the grander conception of the more ancient and unknown writer of Genesis 1st. With supreme felicity of diction and conciseness of plan, the latter has defined the most philosophical views of antiquity upon *cosmogony;* in fact, so well, that it has required the palæontological discoveries of the XIXth century—at least 2500 years after his death—to overthrow his septenary arrangement of "Creation," which, after all, would still be correct enough in general principles, were it not for one individual oversight, and one unlucky blunder,

not exposed, however, until long after his era, by post Copernican astronomy. The oversight is where he wrote, (Gen. I., 6–8,) "Let there be RAQIE," *i. e.*, a firmament, which proves that his notions of "sky" (solid like the concavity of a copper basin, with stars set as brilliants in the metal) were the same as those of the adjacent people of his time, indeed, of all men, before the publication of Newton's Principia, and of Laplace's Mechanique Celeste. The blunder is where he conceives that AUR, "light," and IOM, "day," (Gen. I, 14–18,) could have been physically possible three whole days before the "two great luminaries," Sun and Moon, were created. These venial errors deducted,* his majestic song beautifully illustrates the simple process of ratiocination, through which—often without the slightest historical proof of intercourse—different "Types of Mankind," at distinct epochas, and in countries widely apart, had arrived, naturally, at cosmogonic conclusions, similar to the doctrines of that Hebraical school, of which his harmonic and melodious *numbers* remain a magnificent memento.

That process seems to have been the following: the ancients knew, as we do, that man *is* upon the earth; and they were persuaded, as we are, that his appearance was preceded by unfathomable depth of time. Unable, as we are still, to measure periods antecedent to man by any *chronological* standard, the ancients rationally reached the tabulation of some events anterior to man, through induction—a method not original with Lord Bacon, because known to St. Paul; "for his unseen things from the creation of the world, his eternal power and godhead, are clearly seen, *being understood by the things that are made.*"

* These objections are very fair illustrations of the scioliam of the authors of Types of Mankind. They have been fully refuted in our previous pages.

(Rom. I, 20.) Man, they felt, could not have lived upon earth without animal food, ergo, "cattle," preceded him, together with birds, reptiles, fishes, &c. Nothing living, they knew, could have existed without light and heat, ergo, the solar system antedated animal life, no less than the *vegetation* necessary for animal support. But terrestrial plants cannot grow without earth, ergo, dry land had to be separated from pre-existent "waters." Their geological speculations inclining rather to the *Neptunian* than to the *Plutonian* theory—for Werner ever preceded Hutton—the ancients found it difficult to divide the waters from the waters "without interposing a metallic substance that divided the waters which were *under* the firmament from the waters which were *above* the firmament;" so they inferred, logically, that a *firmament* must have been actually created for this object. [E. g., "The windows of the skies," (Gen. VII, 2;) "the waters above the skies," Ps. CXLVIII, 4.)] Before the "waters" (and here is the peculiar error of the genesaical bard,) some of the ancients claimed the pre-existence of *light*, (a view adopted by the writer of Genesis 1st,) whilst others asserted that "chaos" prevailed. Both schools united, however, in the conviction that DARKNESS—*Erebus*—anteceded all other *created things*. What, said these ancients, can have existed before the "darkness?" ENS ENTIUM, the CREATOR, was the humbled reply. ELOHIM is the Hebrew vocal expression of that climax, to define whose attributes, save through the phenomena of Creation, is an attempt we leave to others more presumptuous than ourselves."

In this brief passage the reader will perceive several important errors—errors, too, which Moses has avoided. It would thus appear that Mr. Gliddon, with all his "processes of ratiocination," and all the "palæontological dis-

coveries of the XIXth century," is unable to give us an account of the Creation as correct as that of the old Hebrew writer whom he so unmercifully ridicules. And we assert, without any fear of successful contradiction, that to arrive, by ordinary intellectual methods, at the conclusions stated by Moses, would require a far more intimate acquaintance with physical science than has been exhibited either by Mr. Gliddon or by Mr. Goodwin, of the Essays and Reviews. Moreover, if we possess this knowledge, we will be led to just those apparent oppositions to ordinary common sense which these gentlemen condemn.

The question then arises: Did the ancients possess such a thorough acquaintance with physical science as would have enabled Moses, who "was learned in all the wisdom of the Egyptians,"* to elaborate by his own knowledge the system which he has propounded?

A very careful examination of this question leads us to say most emphatically that the ancients were not in possession of any such science.

The knowledge possessed by the ancients has been greatly overestimated having been judged entirely by men who were themselves thoroughly ignorant of physical science, and who were readily led away by the dreamy and romantic feelings of reverence which we cherish towards the arts and sciences of those ancient times. Hence, in the popular mind, a high degree of importance has been attached to the crudest of the inventions which have gone out of use, and scholars have excited our wonder and curiosity concerning the skill of the ancients, until some have almost come to believe that all knowledge died with them. We have book upon book detailing and admiring those achievements of theirs which

* Acts vii, 22.

are supposed to be beyond our reach, until the very name of the "Lost Arts" has acquired a charm for most ears—carrying us back, in imagination, to those dreamy times around which twine so many legends and so much mystery —those days in which there were "giants," not only in stature, but in intellect and skill.

In reading the accounts given and lamented over by Pancirrollus, Dutens, Goguet and others, concerning the lost arts, the first thing that strikes us is the ignorance displayed by these men of the state of the arts existing at the time in which they wrote, and we are forcibly reminded of Dr Johnson's remark in relation to Goldsmith's project for sending a scientific commission to investigate the unknown arts of Asia: "Sir, if he went out on such an inquiry, he would bring home a grinding barrow, such as you see in every street in London, and think he had furnished a wonderful improvement."

The fact is, that few literary men are competent judges of the distinguishing features of mechanical inventions, and, consequently, we find the most curious statements constantly gaining currency in the literary world. They quote Solomon to prove that there is nothing new under the sun, and the faintest shadow of a hint by an old author is tortured into a full description, and assumed as evidence that the invention, however recondite, was fully known. Led away in this manner, they assure us, that there were railroads in Egypt, microscopes in Nineveh, and printing machines in China. But they forget to tell us that which is equally true, viz: that the man who first laid down one log so as to roll another over it, laid the first railroad track; the boy who first looked through the silvery drops of dew on a cabbage leaf, used a microscope; and, long before man came upon this stage of existence, there were printers, whose impres-

sions, left upon the sands of Connecticut, endure to the present day.

But any engineer will tell you that a rut such as the Egyptians chiseled in the rocks over which they drew their huge stones, is not a railroad; any microscopist will tell you that a bit of convex glass is very far from being a microscope; and if you inquire of the printer you will find that a wood-cut, however elaborate, will not enable you to set up a printing office.

Hence, despite the boasted achievements of the ancients, every intelligent technologist knows that a railroad upon which men and merchandise can be transported at a speed equal to that of the swiftest bird is a thing not half a century old; a microscope which will reveal the invisible world around us and enable us to enter the penetralia of animal and vegetable life is not much older; while the movable type which confer all its value upon the printing press have not existed during a tithe of the world's historic age. It is true that these gentlemen attempt to make up for all this by treating modern inventions in the same style, and hence we find that when *they* attempt to describe arts and processes they are apt to do so in such glowing terms that the very inventors themselves would fail to recognize their offspring. Read their account of such matters and you will suppose that all difficulties in art have disappeared; that every process advances with "unerring certainty," and every machine works with "infallible regularity." If they attempt to give us an account of the science of the month they seem to possess the happy faculty of producing a brilliant and interesting article from materials which the scientific man hardly thinks it worth while to record. We find them announcing a new invention for reducing metals from their ores by electricity, and forthwith they tell us

that so perfect is the process that copper will become cheaper than iron, and that if our copper coins continue their relation of size to actual value, cents will be as large as dinner plates.* This week we are advised to sell out any shares we may have in gas stock, as the new electric or magnesium light will soon be produced at such a rate, and with so much facility that we shall find it to our interest to dispense even with windows, and the week after we are promised a condensed form of food, which will be palatable, and withal so nutritious that the occupation of the cook will follow that of Othello; pastry shops will be deserted; while so nicely will the ingredients of the proposed form of aliment be adjusted that our children may be grown into physical or intellectual giants, or both, at our will.

Now men who write in this sprightly but loose strain; who draw upon their imaginations for their data and upon their hopes for their results, may produce very readable articles, but they will hardly succeed in giving a faithful and honest picture of the state of the arts amongst us. And if their lucubrations should descend to distant ages, we can picture to ourselves some future Pancirollus or Wendell Phillips descanting upon the wonderful achievements of the nineteenth century; moralizing upon the decline of science and art amongst his *degenerate* contemporaries; and giving a long list of *Lost Arts* which never existed, except upon paper.

A fair specimen of the exaggerated ideas which often obtain concerning the wisdom of the Egyptians is afforded by the "Potable Gold" of Moses. Boerhave in his "Elementa Chemiæ" says: "Moses, who was skilled in the learning of the Egyptians was able to burn gold, so as to reduce it

* This was written before the days of "nickels." The statement was really made by a well-known literary Periodical in their "Science of the Month."

to a powder capable of mixing with water, and fit to be drank, which is one of the highest effects of the art and which the greatest chemists at this day are unacquainted with. Frederick the third, King of Denmark, curious to put this operation in practice, engaged some able chemists of his time to attempt it. After many trials they at last succeeded, but it was in following the method of Moses, by first of all reducing the gold into small parts by means of fire, and then pounding it in a mortar, (along with water to be sure,) till it was so far dissolved as to become potable."

A careful perusal of the sacred author would have saved the Danish monarch all this trouble. There is no ground for supposing that the golden calf was *dissolved.* Moses himself in another place (Deut. IX, 21), describes the process adopted. "I took your sin, the calf which ye made, and burnt it with fire, and stamped it, and ground it very small, even until it was as small as dust, and I cast *the dust thereof* into the brook that descended out of the mount."

The truth is that beyond a familiarity with a few chemicals, including lunar caustic, (which was rediscovered at a very early period in the history of modern chemistry,) the Egyptians had no knowledge of chemistry, and we have not the slightest grounds for believing that their knowledge extended beyond the mere technical uses of these chemical substances. Of their constitution and properties they knew nothing.

We have no reason to believe that even alchemy with its hopes and aims, was known to the Egyptians and other ancient nations. It is certainly not mentioned either by Herodotus or Pliny, who both give an account of the wisdom of the ancients, and undoubtedly had abundant opportunity of acquainting themselves with whatever was known in these early times.

Far less had the ancients any knowledge of those higher departments of science which have opened up to us such wonderful views of the constitution of the universe and the origin of our globe. Astronomy and Geology with their strange revelations, and chemistry and physics with their wonderful laws, are but of yesterday, and have rendered a true scientific cosmogony possible only within the memory of living men.

Beyond all question the knowledge contained in the first chapter of Genesis was not part of the learning of the Egyptians, and to others, therefore, we leave a solution of the question—Where did Moses obtain his wonderfully accurate information ?

THE END.