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The Somerset Herald.

ESTABLISHED 1827.

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Estate of N. B. Snyder, deceased, late of Somerset Township, Somerset county, Pa.
Letters of Administration on the above estate having been granted to the undersigned by the proper authority, notice is hereby given to all persons indebted to said estate to make immediate payment, and those having claims against the same to present them duly authenticated for settlement on Saturday, the 5th day of March, 1887, at the law office of John E. Swatt, in the Borough of Somerset, Pa.
JOHN N. SNYDER,
Administrator.
Jan'29.

SOME OF THE CONCEPTIONS OF MODERN SCIENCE.

BY A. C. HOLBERT.

NOTE.—The following was not written with any intention or thought of publication but for delivery at a local Teachers' Institute, convening at Somerset, Pa., in the evening of Friday, February 18, 1887. After it was delivered at said Institute many of my friends suggested to me to permit them to publish it, and yielding to their solicitations in this behalf I have consented. The ideas have been taken from many sources; the language, where quoted, I have endeavored to mark. Should I have omitted any marks of quotation, where proper, it will be remembered that I composed in haste, and with no thought of publication.—A. C. HOLBERT.

What is heat? Modern Science answers, "Heat is a mode of motion"; and so is electricity; so is light; so is magnetism; so is sound. Heat may be converted into electricity, and electricity into heat. Mechanical motion, which is the motion of masses, may be transformed into either heat or electricity; and both heat and electricity, which are the motion of atoms, may be turned back into mechanical motion. A certain portion of heat, applied in a particular way, generates the motion of a locomotive, and through it of a train of cars. When the brakes are applied the motion of the train is converted into the heat of friction, and the train stops. The changes mentioned are rigidly subject to the laws of quantity. A given amount of one force can produce only a certain amount of another; for instance, a certain amount of motion can generate only a certain definite amount of heat or electricity, and the converse; so it follows that power or energy, like matter, can neither be created nor destroyed by man; it is ever changing form, but its total quality remains, and, so far as we know or can conceive, must forever remain the same,—constant and unalterable.

Every manifestation of force must come from a former equivalent force, and must in action give rise to a subsequent and equal amount of some other force. Hence when any force or effect appears we are not at liberty to suppose that it was self-originated, or came from nothing; and when it disappears from our cognizance we cannot assume that it was annihilated; we must find whence it came and whither it has gone, what produced it, and what effect it has itself produced.

These relations among the modes of energy are called Correlation and Conservation of Force. An hundred years ago if a portion of matter disappeared in the course of a chemical process, the chemist said—"I lose force thereby!" But Lavoisier came with his balance, and the axiom followed, "Matter is indestructible," and a new era arose in chemistry; the doctrines I have mentioned have brought about a new era in their domain also.

Who first proved the convertibility of motion into heat? Answer: A member of the grandest nation on which the sun ever shone, of the nation that has done more for the world in an hundred years than Rome did in a thousand; of the nation that has just entered on a career of glory whose history may not be written for ten thousand years; an American, Benjamin Thompson, known as "*Count Rumford*," born in what is now the United States—in Massachusetts, A. D. 1753. He found that 940 units of force produced an unit of heat; that is to say, 940 pounds falling from a height of one foot generates a sufficient amount of heat to raise one pound of water one degree of Fahrenheit's thermometer in temperature. Fifty years after Rumford J. P. Joule proved that 772 pounds falling one foot will raise the temperature of one pound of water one degree of Fahrenheit. This number 772 is accepted the world over, and is called the "Mechanical Equivalent of Heat." Rumford was within 20 per cent of truth, on the very first trial ever made in the world.

A few words regarding *Perpetual Motion*. I want to show the boys here that such a thing *cannot be*—and I may save some of them headaches and heartaches in the future. By perpetual motion is meant this, for example: a weight by its fall may turn a wheel; this wheel in turning would raise the weight that started it, the weight would fall again, and the process be repeated forever—or until the machinery was worn out. Now mark me: if the first weight is to be raised by the force that it has itself generated, it must generate a force greater than its own weight; in other words, it must be able to raise a weight heavier than itself; to conceive such a thing we must conceive something heavier than itself. You see the absurdity. Here is an American's way of doing it. By means of electricity he said that he had decomposed water, forming its elements—oxygen gas and hydrogen gas; that he had burned the hydrogen in the oxygen, in contact with quick lime, forming the Drummond or Calcium light, and generating intense heat; at the same time the hydrogen and oxygen reunited in combustion, and formed water again; with the heat mentioned he had driven a small steam engine, which had driven the electric machine from which the first supply of electricity was derived; with this he had again decomposed the water that had been formed from the two gases, re-preparing the first, and so on continually. There is not a single step in all this that any scientific man will not tell you is possible, hence the scheme looked plausible. But when it came to uniting all these—then men said in disgust, "It can't be done." Why? Practical men said "The force of friction in machinery is at least one-third; the force generated, so three-thirds power must equal or produce four-thirds effect. This can't be." Scientific men said, "It is contrary to the doctrine of Correlation of Force—hence is impossible." But let me tell you, this very thing set the industrial part of Europe crazy a few years ago. A man in New York City to-day says that by drawing a diddle-bow over a cert in arrangement, he can generate a force stronger than a thousand steam-engines—you recognize the "Keeley Motor." What do I say about that? I say that it is contrary to the doctrine of Correlation of Force and I don't believe a word of it.

What is *Sound*? The dictionaries tell us, "A sensation excited in the ear by the vibrations of air, or some other medium." Here we run on motion again. If I strike my hands together, motion is imparted to the air; this is imparted to that outside its space, and so on, as Tyndall says, "each shell of air imparts its motion to the shell immediately outside it until it reaches your ears as a pulse or wave of air," strikes the tympanum or drum of your ear, passes along the auditory nerve, to the brain, which it reaches as sensation. Helmholtz first determined the speed at which sensation of any kind travels along a nerve, to be 93 feet a second. How fast does sound travel? At an average about 1120 feet a second, but at the zero of Centigrade thermometer 1092 feet a second. Temperature exerts an influence, we see. Sound and light are both sensations caused by undulations or waves. The length of sound-wave generated by a man's voice, in common conversation, is from eight to twelve feet, by a woman's voice from two to four feet. A woman's voice in ordinary conversation or pitch is more than an octave higher than a man's; in the higher sounds it is two octaves. Any one will admit that a sound may be solar that he cannot hear it, though another may. But not everyone will admit, at the first statement, that a sound may be pitched so *high* that he cannot hear it, though another may. Yet such is the fact. Helmholtz has found that sixteen vibrations, or sound waves, a second is the lowest number that can be heard, while 38,000 vibrations or sound-waves a second is the highest number that can be heard. So long then as a sound is not so low as to send less than sixteen vibrations or so high as to send more than 38,000 vibrations a second to the ear, it can be heard by some one; but ears are not keyed to the same pitch. Suppose my ears are keyed to 25 vibrations and to 22,000 vibrations a second, while the normal is 16 for low and 38,000 for high. Then you can see that my ears will be stopped to many sounds, both high and low. Many persons cannot hear the squeak of a bat, or the note of a cricket, or the chirp of a sparrow, because these are high-pitched notes—too high for their ears, and remember such persons are not deaf. You will think of this when I come to explain color-blindness, by and by.

What is light? Long, light is a mode of motion. I have already said, "Sound and Light are both sensations caused by undulations, or waves." The old theory of light, advanced by the great Sir Isaac Newton, and called the "Emission" or "Corpuscular Theory," was that Light consisted of very small particles of matter, shot out with inconceivable rapidity by luminous bodies; that these particles were so fine as to pass through the pores of any transparent substance; hence they could readily pass through the exterior coats, and the humors of the eye, strike against the expansion of the optic nerve known as the retina, and in some way excite vision or sight. I want to look at some of the difficulties in the way of this theory.

First, I want you to take my word for it, light travels 192,000 miles a second—let us fix this in our minds. The earth is say 25,000 miles in circuit; if light could travel in curved lines and be made to pass around the earth, a particle of light would pass 7½ times around the earth, between two ticks of your watch. One of our railroad trains here runs, I suppose, thirty miles an hour; it would take it 8 months, 26 days, 16 hours, without a stop, to travel the distance light goes in the single swing of the pendulum of a grandfather's clock. All bodies have weight. These particles, if they exist, are no exception. A bit of matter one grain in weight, moving with the speed of light would strike as hard as a 1-lb. pound cannon ball moving 1,000 feet a second. This is calculation—not guess work. If light particles exist, untold millions of them have been concentrated by lenses and mirrors and shot against a balance suspended by a single spider's thread; this thread, though twisted 1,000 times, showed no tendency to untwist. It was without torsion; no motion was observed. These concentrated millions of particles possessed no weight, driven with the speed of 192,000 miles a second. Can you believe this theory after this statement? I cannot. There are other objections on which I shall not dwell.

The other theory is called the "Theory of Undulations," and was advanced by the celebrated astronomer Huyghens, and the no less famous mathematician Euler. Laplace, Biot, Malus and Brewster supported Newton and the "Corpuscular theory"; but it was finally overthrown by the labors of Dr. Thomas Young and Augustine Fresnel.

A wide-awake boy might say: "But the earth's atmosphere doesn't pervade all space. What is there to make waves in it?" The point is well taken. I can only answer: There is a supposition in this just as there is in the "Corpuscular Theory." There is supposed to be a substance—a kind of universal atmosphere, pervading all space, extending everywhere, even between the atoms of the most solid bodies—it has been named the Luminous ether—that is the light carrying atmosphere. In it waves are generated in a manner similar to that previously explained for sound. Bear in mind one fact just here: before any reasonable creature can accept any theory he must be satisfied that it is the best means of accounting for the various phenomena happening in that part of the natural world. Now this wave theory is not only the best, but it is the *only theory* that will exclusively account for all the various phenomena connected with light; the Emission Theory fails to account for some of the phenomena, hence this is rejected, that accepted by all men of science the world over—except a few self-styled scientists whom other men call cranks. It is very easy sometimes to "make or break a faith," and until you have something at least as good to shelter you—better not break it.

Almost every one knows now that there are seven colors, and that when they are separated by a prism, or similar means, they are called the spectrum—sometimes the solar spectrum. The blending of all these colors produces white light—and the entire absence of color is black. These seven colors blended in order of greatest refraction are, violet, indigo, blue, green, yellow, orange, red; you remember by the word "*vibgyor*."

The *color* of light, like the *pitch* of sound is determined only by its wave-length, so that the color of the first corresponds to the pitch of the second. The ether wave that forms red is about 17 times as long as the ether wave that forms violet. About 39,000 waves to an inch of space forms red, but it takes 575,000 waves to the inch to form violet; in other words, a red wave is one 39,000 and a violet wave one 575,000 of an inch long. Any school boy of 14 can tell how many waves of ether kind there are in 192,000 miles. Of red, 474,439,680,000,000, waves is the number, and of violet it is 699,440,000,000,000, or in round numbers 6 with 15 ciphers after it, and all these waves whether of red or violet, enter the eye in a single second. Think of it! 474,000 millions of millions of waves enter the eye in a single second to form red, while six thousand billions of billions of waves enter it in the same time to form violet. What conception can we have of such numbers? But the emission theory deals with numbers equally large, and as Sir John Herschel says: "There is no possible way of looking at the subject that does not call our attention to mechanical forces that we can only think of by the term infinite."

Bearing in mind now that Color in light corresponds exactly to Pitch in sound, any one can understand color-blindness. If the eye is not keyed to respond to the proper number of vibrations to make up red, that eye will be blind to red, though it may see other colors, just as the ear is deaf to any sound to whose vibrations it cannot respond. We occupy one of eight planets; it is known as earth, third in position from the central luminary known as the Sun, revolving about him in something more than 365 days, producing in our latitude four seasons, turning also on its own axis once in 24 hours, producing the phenomena known as day and night. A definition similar to this—perhaps not quite so good—has been all that many a man knew about the earth, and yet he lived well and died happy, and I presume went to heaven. I sometimes think "don't well to know too much. Byron says in Manfred: "They who know the most must mourn the deepest o'er the fatal truth. The tree of knowledge is not that of life."

What is the Sun? From the bi-best point of view, he is a single star among millions—thousands of which exceed him in brightness, magnificent power. But he is the only one of the stars that is near enough to us to produce any sensible influence upon the affairs of earth. To him we trace nearly all the energy involved in all phenomena, mechanical, chemical or vital. Cut off his rays for a month, all life on earth would cease. Earth would die, and the poet's dream be realized:

"The world was void,
The populous and populous once a lump,
Seasonless, herbless, treeless, manless, lifeless—
A lump of death—a chaos of hard clay."

The sun is the source of all energy upon earth. A watch runs by the force of a coiled spring, a clock by the force of a weight running down, even the brain thinks by force of energy derived from the burning up of food in that furnace, the stomach, and all animal motions are the result of the consumption of food; plants grow for a similar reason; the Niagara goes on from year to year, pouring over 600,000 tons of water per minute over that precipice, has worn its way more than 20 miles up the river through walls of limestone and its mighty roar is never silent—has never been silent; a rifle-ball is driven by the force of gunpowder—a thousand instances might be named.

A watch-spring or the clock-weight runs down, the fuel put into the stomach, the stove, the lamp, the engine fire-box burns out, the powder vanishes in smoke, dust and gas. Before another rifle-ball can be driven either a new charge must be furnished, or the materials of the old charge must be gathered up and re-combined—it is easier to do the one than the other; before the engine can go, fresh fuel must be supplied to its burnt out fires; before the lamp can again give light, before the brain can again furnish thought, each must likewise receive a fresh supply of fuel; tension must be restored to the unwound spring, the run-down weight must be re-wound, or the wheels will cease to turn; the clock or watch will be silent and useless as a timepiece. Why is it that the cataract can roar to the skies, "Men may come and men may go, but I go on forever?" Is it an exception to the law of the "Correlation of Force?" No. The mighty Niagara, or Mississippi, or Amazon, or Ganges, as well as the smallest rivulet originating in one of our mountain springs, whose crystal waters an ox may daily drain dry, requires to be renewed just as much as the unwound watch-spring. Niagara must be wound up or it will cease to flow, just as surely as the pendulum of the clock will cease to swing when the weight has run down. That mighty sun is continually taking from the sea the waters that have run into it? They rise in vapor, they float above us in beautiful, ever-changing, glorious sunrise or sunset, or in sable, portentous, lightning-charged, hurricane-bearing cloud-masses of darkness and storm, they fall in pattering rain, in driving hail, in cold, silent, beautiful snow—and so the sources of the rivers are renewed.

When many of us were boys we were taught that the sun was, on an average, 95,000,000 of miles away from us, but it isn't true—its average distance is 95,000,000 of miles, his diameter is 865,000 miles; but if a piece of him could be cut off as large as the earth it would weigh only one-fourth as much as the earth, or about one and a quarter times as much as an equal mass of water. Some one says, "What do we care about these things? What difference does it make to us whether the sun is 95 or 95 millions of miles away?" In dollars and cents perhaps none. You'd get along perhaps just as well if you believed he were only a mile away, and that he wasn't bigger than a cart-wheel. But the sun's distance has been called the "yard-stick of the universe." All astronomical calculations depend upon it. An uncertainty of one per cent in the sun's distance means an uncertainty of more than three per cent in every celestial mass, and in every cosmical form. Besides, there is no more difficult problem in Astronomy. When a surveyor wants to find the distance of an inaccessible object, he lays off a convenient distance calling it a "base-line"; then he measures the angle formed at the ends of the base-line with lines drawn to the object, and a surveyor who cannot get a base-line at least one-tenth of the distance to be measured thinks he is very unfortunate. But the Astronomer's base line is the whole diameter of the earth, and it is less than one eleven-thousandth of the distance of the sun, so that the astronomer finds himself in the predicament of the surveyor who, having to measure the distance of an object ten miles away, finds he can get a base-line less than five feet long. Ask any surveyor what he'd think of such a case. I have said "the diameter of the earth is the astronomer's base-line"; this needs some explanation; the astronomer's real base-line is the half of the diameter of the earth as it would be seen from the sun, and is called the "parallax." This is less than nine seconds of arc, almost certainly between 8.75 seconds and 8.85 seconds, a difference of one-tenth of a second, but this one-tenth of a second is more than one one-hundredth of the whole, and yet it is no more than the angle formed by lines drawn from opposite sides of a single hair to a point 800 feet away. Suppose we call the parallax 8.80 seconds, which is known to be very nearly true; the sun's distance will come out 92,885,000 miles, but a variat on of one-twentieth of a second either way, will change the distance about half a million miles. Now call the distance 92,885,000 miles, which is very nearly true, and let me give you a few figures. Suppose a man starts to walk such a distance, walking four miles an hour every day, Sundays included, for ten hours, in 68 years he will walk a million miles, and in 6,800 years he would reach the sun,—about seven times the recorded age of Methuselah.

A railway train running 60 miles an hour day and night without a stop will require over 175 years to reach the sun. Suppose such a train to start on the tremendous journey, and the life of any one of the employes to be 50 years—by and night they go on, the first set die and their children take charge, they die and the grandchildren of the first set are running the train, these pass away, and when 25 years more have gone by the train goes rush into the station with the embalmed bodies of their parents, grandparents and great grandparents to be buried in the grand mountain-furnace of the Universe—the life-giving sun.

Prof. Mendenhall illustrates by saying: "Suppose a little baby had an arm long enough to grasp the sun as some beautiful toy, that he should do so and burn its fingers, he would die of old age and his children would be in their graves before pain could be felt, because sensation travels only 95 feet per second—say 100 feet—1667 miles a day, more than 166 years would be required for the journey. Sound, at an average speed of 1120 feet per second, would do it in about 11 years, if it could be transmitted through celestial space.

A cannon-ball at a constant speed of 2000 feet per second—their speed at leaving the gun would require about nine years.

If the earth could be suddenly stopped in its orbit and fall into the sun, she would reach it in about four months.

The earth herself moves nearly 19 miles a second, more than fifty times faster than the swiftest rifle-ball, and in moving 18 miles her path lacks only one-eighth of an inch of being a straight line.

The diameter of the sun is about 865,000 miles, 109 times that of the earth, so it follows that the man that made the "Tour of the world in 80 days" would require nearly 24 years for the tour of the sun.

The surface of the sun is nearly 12,000 times that of the earth, and its volume is more than 1,300,000 times that of the earth, that is, if earths could be packed into the sun like peas in a glass ball, but filling all the space, more than 1,300,000 earths would be required. If I represent the earth by a three-inch globe, I must represent the sun by a 27-foot globe, and the distance by 3,000 feet to place them all on the same scale. Imagine the earth placed at the centre of the sun, the moon, which is only 240,000 miles away from the earth, could perform its revolutions, and there would be room for another moon to revolve 100,000 miles beyond our moon.

When we attempt to conceive the mass or weight of the sun we are utterly lost, even when we put it in tons. It is two octillions of tons—that is, 2 with 27 ciphers after it.

When we talk of the amount of attraction between the sun and the earth, we are again lost. It is 36 quintillions of tons—that is 36 followed by 17 ciphers.

Let me give you another illustration from a calculation by Mr. C. R. Warring. Imagine gravitation to cease, and its place to be supplied by a rod of steel wires as large as the largest telegraph wires, which are No. 4. Now in order to prevent the earth from flying off into space, these wires would have to cover the entire sunward surface of the earth, half the surface of our globe, sh ot as thickly as the blades of grass grow on a lawn. There would have to be nine to the square inch.

If we calculate the force of gravity at the sun, which is easily done by dividing its mass 330,000 by the square of 109, (the number of times its diameter exceeds that of the earth), we find it to be 27½ times as great as on the earth; a man that here weighs 150 pounds, would there weigh nearly two tons, and would be unable to move. A body that here falls 16 feet in a second would there fall 443 feet. A pendulum beating seconds here—that is swinging once in a second—would beat more than five times fast there, so that it would quiver rather than swing.

The sun is intensely heated; I will tell you how hot it is by and by, perhaps I should say how hot it *must be* to furnish the amount of heat that it does. We know that many substances with which we are familiar exist in the sun; iron, calcium—one form of which is lime—sodium—one form of which we use under the name of salt, copper, lead, hydrogen, nickel, cobalt, aluminum—our new metal, and some others. In all 22 of the from 60 to 80 subs ances known on earth as elements exist in the sun. They exist in the form of gases; iron there is not a metal, it is a gas. Think of this fact; if there be such a thing there as rain—or anything resembling what we call rain—that is the fall of condensed vapors,—it is not, it cannot be water that falls, but it must be drops of molten metal. Imagine a rain-storm of drops of melted iron, copper, or even lead. How do we know that these substances exist in the sun? If you see a handwriting you will be able to tell who wrote the manuscript, if you are familiar with the writing. The Attorney's of this or any other bar can swear to the handwriting of one another. An expert in paintings will tell you by which of the "Old Masters" any picture was executed, he could not mistake a Raphael for a Rubens.

Now, if you take a piece of sheet copper, or an ounce of copper filings and throw it in the fire you'll see green flames rising, if you use zinc you'll see blue flames, etc., etc. Now these blue or green flames of zinc or copper, when formed by the electric light and sent through a prism—or other properly prepared apparatus, will form a line of light of a certain color. Suppose that a ray of sunlight is sent through one half of a prism at the same time that a ray of metal-tinted electric light is sent through the other half. Any one can see that each will make its "handwriting on the wall." Suppose that you find, in one half of the prism a line exactly like a line in the same place in the other half what do you conclude? You must conclude that they were written by the same hand, in the same ink, that is to say by the same element, metal, or whatever it be. In this way the 22 elements have been named, each one of them has written its own signature in colors drawn from the lightning and the glorious sunshine—and will make it for anyone that puts its pen into its hand. These signatures to the trained eye can never be mistaken the one for the other for there are no two elements known to man that give exactly the same colored line.

The sun turns on its axis in about 25 of our days, or, if the sun could have anything corresponding to day and night, each would have to be 12½ of our days long. A very curious thing is that not all of his surface turns in the same time. Take an apple, make a mark all around it midway between the stem and blossom, this is the apple's equator, now make another mark from stem to blossom, this is a meridian, stick a pin in this meridian up near the stem, another where the equator crosses the meridian, and a third down near the blossom. Now if you revolve this apple holding your finger and thumb at the stem and blossom respectively, the pins will all come to a given line at the same time—if they were stuck in the sun they would not do so; the one at the equator would go around sooner than the others—it would seem to have been pushed along ahead of the others—the part outside seeming to have been slid over the mass inside it—hence some points get around in 25, others in 26, and yet others in 27 of our days. No explanation supposed to be sensible has yet been given of this very remarkable circumstance, unlike every thing else we know of in the economy of the planets.

How hot is the sun? Well! I promised to tell, and I redeem that promise by saying—it is awfully-awful hot. Herschel, by careful experiments, concluded that the amount of heat received on the earth's surface with the sun in the zenith would melt an inch thick of ice in 2 hours 15 minutes. Suppose this true, and the sun surrounded by a shell of ice an inch thick, extending in every direction about 186 millions of miles away from him—I may say here that this, 186 million miles, is double the earth's distance from the sun—just as the shell of an egg surrounds the yolk, and this shell would be melted in the same time. Suppose again that this shell should shrink in size, but increase in thickness, we readily see that no matter how thick it becomes it will only require 2 hours 15 minutes to melt it. Suppose the sun's fires to be banked, and this mighty shell to shrink until it lies on the sun, it will be piled up all over him more than a mile high, now turn loose the vast furnace and it will still melt off all this ice in just the same, 2 hours 15 minutes—more than 40 feet a minute. Form all this ice into a solid rod forty-five and three-tenths miles in diameter, and dart it toward the sun with the speed of light, 192,000 miles a second, and it will never reach the sun—it will be melted off as it goes. Here is another illustration. Build up a solid column of ice from the earth to the sun, 2½ miles in diameter, bridging over that mighty chasm of 93 millions of miles, let the sun concentrate his power upon it, it will dissolve and melt, not in an hour—not in a minute—but in a single second—one swing of the pendulum, it will be water—seven swings more, and it will be vapor. Think of it. Sir Wm. Thompson has shown that if the sun were solid coal and produced its heat by burning it would burn out in less than 5,000 years.

But the earth doesn't get all the sun's heat, only a very little of it—one 2,300 millionth of of the whole, is what we get. It doesn't seem to be a very large part, but it's enough. I've said that heat is a "mode of motion." How much motion will make the amount of heat that we get from the sun? More than 60 tons dropped from a mile high on every square foot of the surface of the earth. To put it in horse powers: it would take a one horse-power engine, acting constantly on every 30 square feet of the earth's surface.

The sun's temperature has been placed as high as 18 million degrees of Fahrenheit's thermometer, and as low as between 3,000 and 10,000 such degrees. The problem is a very difficult one, because so many circumstances enter into the calculation. We know that the most powerful lens yet made transports an object at its focus to within 250,000 miles of the sun, and that the most refractory substances—platinum, fireclay, the diamond itself—are either instantly melted or sentenced in vapor. Prof. S. P. Langley, who is now writing a series of Astronomical Articles for the *Century*, puts the temperature of the sun at more than 87 times that of the molten iron in a Bessemer Converter, and the temperature of such iron is at least 3000 degrees Fahrenheit, or the sun's temperature must be according to Langley, at least 261,000 degrees of Fahrenheit. The sun's light I may say has been estimated at the number of candles denoted by 61 with 29 ciphers after it, 5500 times that of a Bessemer Converter, 146 times times that of a calcium light, 3 4-10 times that of the electric arc.

And now come questions like these: How is such an enormous heat maintained? How long has it lasted? How long will it last? Are there any signs of increase or of diminution? And I frankly say that at present the answers of science are somewhat vague, and unsatisfactory. There have been no great climatic changes within 2,000 years; so far as we know the vine and the palm tree grow just where they did in classic times, the same is true of the cereals, the bread grains, and of our forest trees. No matter what the Geologic past may have been, the pen of history has recorded no change in all the centuries that it has been writing the annals of humanity. If the sun were solid coal it would have been nearly one-third burnt out since the Christian era.

Two theories have been proposed. The first finds the source of heat in bodies falling into the sun, the other in the contraction of the sun by cooling. If you strike a metallic rod, or ball, a heavy blow with a sledge, the rod or ball becomes hot, several quick, smart blows will heat it red. So if you place a piece of metal under a powerful press, and, after permitting the press to exert its power, remove the metal quickly you will find it hot. Both these theories may be true to some extent.

Suppose the earth were to fall into the sun, it is known that enough heat would be generated by the blow to maintain the sun's present heat for almost 84 years, 83 years, 328 days more nearly exact. The eight large planets would keep up his temperature for 17,034 years. A quantity of matter equal to one eighty-third, say one one-hundredth of the earth's mass falling on the sun for a the same distance as the earth, would keep up the engine room maintain the sun's heat. Much matter may, dust, fall into the sun from immensely greater distances than the earth. Some may say, "But such a store of matter would increase the size of the sun, and, by increasing the speed of their revolution, shorten the years of all the planets." This is true, but we must bear in mind that the sun is 109,000 times as large as the earth, so the supposed yearly addition would be only about one 30 millionth of his mass, and days would be required to make the addition sensible to us.

Regarding contraction I may say that since the sun's gravity is 27½ times as great as the sun and the earth, heat must be produced thereby in enormous quantities in the sun, regardless of whether his heat be thus maintained or not. Helmholtz, who originated the theory in 1854, concludes that under the most favorable supposition, a contraction of the sun's diameter of about 230 feet a year, or a mile in a little over 21 years, would account for the entire annual amount of heat given off by the sun. This amount of contraction would be imperceptible; it would take 5000 years to reduce the sun's diameter one second of arc, and nothing less would be certainly detectible at the sun's distance.

"On a bright night twenty minutes rarely pass without the appearance of at least one meteor. Taken a year, on the 12th of August and the 14th of November, they appear in enormous numbers," so says Prof. John Tyndall, and so say many works on Astronomy. Two hundred and forty thousand meteors have actually been observed to fall in 9 hours in Rome. Hundreds or even thousands of millions may, doubtless, do fall in a year; and even such a number is a very small fraction of the crowd of asteroids that circulate around the sun. From the phenomena of light and heat, and by direct observations on Encke's comet, we know that the universe is filled with a resisting medium, by the friction of which all the masses of one system are gradually being drawn toward the sun. The large bodies the planets of our system show no decrease in their time of revolution, at least in historic times, but it may be otherwise with smaller bodies. In this case required for the earth to alter its distance from the sun by a single yard, a smaller asteroid may have been drawn in thousands or even millions of miles. It is easy to calculate the maximum or greatest, and the minimum, or least, velocity imparted by the sun's attraction to an asteroid circulating round him. The former is when the body approaches the sun from an infinite distance, because the entire pull of the sun is then exerted upon it. The latter is such a velocity as will barely enable the body to move round the sun close to his surface. The final velocity of the first just before striking the sun would be 390 and of the second 276 miles in a second. By the former the mere striking would develop more than 9,000 and by the latter more than 4,000 times the heat generated by burning an asteroid of the same size, composed of coal. Remember we set it it makes no difference whether such a body be combustible or not, as regards the amount of heat generated, its being so would not add visibly to the same.

There is another consideration that I want to mention, and it regards the earth. If you and I could stand at the mouth of the Amazon, or some other river flowing into the open ocean, we would see the current reversed and the water running upstream twice a day. This water takes an apparently unnatural course, it runs up hill, it generates friction between itself and the bed and sides of the river. This friction produces heat. A part of this heat is sent off—radiated—into space and so far as the earth is concerned, is lost. What supplies this constant loss? I answer, it is supplied by the earth's turning on its axis once in every 24 hours. The water, mentioned above, as running up hill is the "tidal wave." It is dragged along the surface of the earth, in a direction contrary to the earth's rotation. Hence, I may call it an immense brake, whose action is to lessen the speed of the earth's rotation, just as a brake lessens the speed of the rotation of the wheels of a train, or of a wagon. Suppose two mills, one turned by the action of the tide, the other by that of a mountain stream. The first grinds your grain at the expense of the speed of the earth's rotation, the second at the expense of the sun's heat that lifted the river to its source.

But here is another—I was about to say speculation, I will say fact, this mighty brake through continually causing a loss of motion must eventually c