THE YEAR AND THE DAY.

Our satellite the moon has this remarkable property, that it turns on its own axis in precisely the same time that it takes in completing a revolution round the earth. The result of this is that men have been known to state, with an air of scientific research, that it does not turn on its own axis at all. But *fiat experimentum in corpore vili,* for, as Herschel remarks, if a man will only walk several times round a stick, with his face always towards it, he will find from the unpleasant sensation of giddiness that he has been rotating on his own axis also.

Now, the earth moves in a most confusing manner round the sun. It rotates on its axis about 365 times while it revolves about the sun; if it were exactly 365 times, the year would be difficult to manage, on account of its not being readily divisible into months or other periods. But it is about 365¼ times, and, to make the confusion worse, it is less than this number by an insignificant fraction, which *will* make itself known in course of years.

If we were to go back to the earliest correct, or moderately correct, notion of the length of the solar year, we should probably find it among the Chinese. But in their case it is impossible to tell what is false and what true. If, however, we are to believe their historians at all, we shall have to allow that in knowledge of this sort they anticipated Europeans by about two thousand years. The Chaldeans and the Egyptians were very early in the pursuit of astronomy, yet quite modern in comparison with the Chinese. In Europe, the Greeks, at an early period of their history, were aware that the revolution, called the solar year, occupied about 365¼ days, but for a long time could not arrive at a more exact determination, and it was not till 140 B.C., that any accurate idea was formed. At that time lived Hipparchus, otherwise "the Father of Astronomy." He pursued the science in Rhodes; and by comparing his own observations of the summer solstice with those taken by Aristarchus about 140 years before, he arrived at a fairly correct result; in fact, whatever inaccuracy there was lay chiefly with Aristarchus. Modern investigations give as the exact time occupied by the earth in moving from a point in the ecliptic to the same point again, 365 days, 5 hours, 48 minutes, 49·62 seconds.

The Romans seem not to have had the advantage of even the imperfect knowledge possessed by the early Greeks; and as our calendar has come down to us directly from them, it will be our object to examine the development of their system. At first the moon was their guide.

Romulus instituted an arbitrary year of 304 days, containing ten months, and commencing with March. Numa, finding that this was so far from the length of the solar year, and that consequently the seasons occurred at different times in different years, added two months, January at the beginning, and February at the end. Here, by the way, we may mention that in 452 B.C. the Decemvirs altered the order, putting February between January and March. Numa's year contained 354 days; and the superstition of the times caused the addition of a day to make it an odd number, which was considered more lucky.

Thus the year became 355 days. This was known to be too short. Numa therefore ordered that every other year a month should be inserted between two days near the end of February, which month should consist alternately of twenty-two and twenty-three days. But notwithstanding this clumsy arrangement, the year was still nearly a day too long, for it was brought up to an average length of 366¼ days. Lastly, this inaccuracy was to be overcome by the omission of one intercalary month in twenty-four years. This was pretty accurate, and might have worked well, but it was left in the hands of the pontifices. Some say that they abused their power over the length of the year to serve political or personal objects. It may have been from ignorance or carelessness; but certainly when Julius Cæsar, as pontifex maximus, examined the state of the calendar, he found that winter months had crept back into autumn, and the heat of summer was raging in the months of spring.

At this period he called to his aid the astronomer Sosigenes, by whose advice the so-called Julian Calendar was framed. The lunar year was abolished, and with it the confusing arrangement of intercalary months. Cæsar ordered that the average length of the year should be 365¼ days; and. to effect this, decreed that every fourth year should contain 366 days, ths others 365, so that there would at first seem to have been very little change from that time till now. But again the pontiffs interfered with the working of it. The Romans had a peculiarity in computing intervals of time which may have caused a mistake in the arrangement of the leap years. They always counted intervals as including the extreme limits; that is to say, they would call the 5th day of a month the 3d before the 7th; we should call it the 2d before it. At all events, the pontiffs, instead of making every fourth year, made every third consist of 366 days. The error thus introduced was gradually corrected by Augustus; it was not large, and therefore he had not to resort to the violent measures of his predecessor Julius, who made the year of his reformation consist of 445 days, which truly was a "year of confusion."

Our months are necessarily of different lengths, but they might be more evenly arranged. They seem to follow no law except that of the little rhyme, which every one is supposed to know. Had we received the Julian system unaltered, this little poem about the thirty and the thirty-one days would never have been needed. The original distribution was such that the months were alternately composed of thirty-one and thirty days in the leap years, and in the other years a day was taken from February, which was always regarded with spite as an unlucky month. Thus, July consisted of thirty-one days, August of thirty. Accordingly, in the time of Augustus, gross adulation caused a day to be taken from February, the poor, unlucky, but ill-used month, and added to the one which bore the emperor's name. merely that his month might not be shorter than July, his predecessor's. The emperor *may* have been gratified by the attention, but it is hard that we should suffer for it.

The Julian method was nearly complete; the year thus established was only 11 minutes 10·35 seconds too long, which amounts to a day in 129 years.

When the Julian Calendar was instituted, the vernal equinox was fixed at the 25th of March; and had it not been for the slight error in the length of the solar year which resulted from the arrangement of Sosigenes, we should probably still have it on that day. As it was, however, the equinox receded; and at the Council of Nice, in 325 A.D., it was settled that the 21st should be distinguished as the day of its occurrence. And here it is remarkable that no correction was made which would prevent further recession, and absolutely fix the equinox on the 21st. The existing calendar was very convenient, simple, and accurate, as far as temporary results; but the error induced must have been manifest; and it must also have been clear that in every four centuries the seasons would be one day out of place.

The necessity of reformation was felt by the Venerable Bede as early as the eighth century; it was subsequently recommended to the pope by the philosopher Roger Bacon; but the first attempt at correction was made in the fifteenth century by Pope Sixtus IV. To assist in this he invited the great astronomer of that time, Regiomontanus; but by the death of the latter, the project was not carried into execution until the accession of Gregory XIII. to the papacy. His system was as follows: The Julian plan of intercalation was adopted, with the exception that the first year of a century should not be a leap year unless it were divisible by 400. Thus the length of the year was brought so nearly to exactitude that in a period of three thousand years the error amounts to less than a day, which is certainly of no great importance. This reformation was made in 1582; and it is a curious coincidence that whereas the Julian Calendar was finally drawn and fully written out by a scribe named Flavius, the Gregorian was published and explained by Clavius.

The reformed or Gregorian Calendar was almost immediately adopted in all Roman Catholic countries, and the seasons were brought back to their original places in the year by the omission of the ten days which had accumulated since the Council of Nice. In Scotland it was adopted in 1600, and in the Protestant States of Germany in 1700. In England the *vox populi* was so strongly opposed to change that no alteration was made until the year 1752; and, indeed, when the change eventually came, it brought with it a most ridiculous outburst of popular ignorance. The 2d of September of that year was followed by the 14th; so that the eleven days, which was the amount of difference between the old style and the new, were omitted in that month; and the lower orders of the nation, under the impression that they had been unwarrantably deprived of something, clamored vehemently but fruitlessly for the restoration of these days. At the present time Russia is the only European country which adheres to the old style.

All things considered, our calendar seems remarkably simple, and, for all human purposes, sufficiently exact; but, in conclusion, we will quote a passage from Herschel's "Astronomy" with reference to the system adopted in Persia;

"A rule proposed by Omar, a Persian astronomer of the court of Gelaleddin Melek Schah, in 1079 A.D. (or more than five centuries before the reformation of Gregory), deserves notice. It consists in interpolating a day, as in the Julian system, every fourth year, only postponing to the thirty-third year the intercalation, which on that system would be made in the thirty-second. This is equivalent to omitting the Julian intercalation altogether in each one hundred and twenty-eighth year (retaining all the others). To produce an accumulated error of a day on this system would require a lapse of five thousand years; so that the Persian astronomer's rule is not only far more simple but materially more exact than the Gregorian."—*Chambers' Journal.*

Spontaneous Combustion.

Instances of spontaneous combustion are so common now-a-days that we cannot help thinking that people are becoming more careless than they used to be, or else they are ignorant of the nature and the causes of this kind of combustion. The latter, we doubt not, is more frequently the case, and this is our reason for taking up the subject here.

Our readers are aware that ordinary burning is nothing but rapid oxidation, or the union of the combustible substance with the oxygen of the air. But they may not all be equally familiar with the philosophy of slow combustion, which is a more gradual oxidation of a substance. The decay of animal and vegetable substances is a process of this sort. When a log of wood rots in the forest, it is as really burned up as when it blazes on the hearth of an old-fashioned fireplace. The carbon and hydrogen which make up the greater part of its bulk are oxidized in the former case, as in the latter, and the products of the combustion—carbonic acid and water—are the same. And it has been proved that the heat generated in both forms of burning is precisely the same; the only difference being, that in ordinary burning it is all set free in a short time, while in decay it is developed so slowly that we do not perceive it.

The rusting of metals is another instance of this slow combustion, the rust being the metal after it is burnt, or oxidized. Heat is generated in this process, as in that of decay; and if the rusting can be made sufficiently rapid (as when a large pile of iron filings is moistened and exposed to the air), the rise of temperature is readily detected. A remarkable case of heat developed in this way occurred in England during the manufacture of a submarine cable, and is described in Rolfe and Gillett's "Natural Philosophy:"

"The copper wire of the cable was covered with gutta-percha, tar, and hemp, and the whole inclosed in a casing of iron wire. The cable, as it was finished, was coiled in tanks filled with water; these tanks leaked, and the water was therefore drawn off, leaving about 163 nautical miles of cable coiled in a mass 30 feet in diameter (with a space in the center 6 feet in diameter) and 8 feet high. It rusted so rapidly that the temperature in the center of the coil rose in four days from 66° to 79°, though the temperature of the air did not rise above 66° during the period, and was as low as 59° part of the time. The mass would have become even hotter, had it not been cooled by pouring on water."

In this case the heat set free caused the oxidation to go on faster and faster; and this is what occurs in spontaneous combustion, which is simply "rapid combustion developed gradually from slow combustion." There is no more common source of such combustion than the oily rags used by painters in their work, or the cotton waste used for wiping machinery. When such substances have become saturated with oil, if they happen to be thrown into a heap, the oil begins to oxidize slowly; but the heat produced makes the oxidation more and more rapid until the mass bursts into a flame. Oils that oxidize readily, like cotton-seed oil, are especially liable to take fire. Oil spilt on dry sawdust has been known to ignite in the same way.

It sometimes happens that hay, cotton, and many forms of woody fiber—as tow, flax, hemp, rags, leaves, spent tan, straw in manure heaps, etc.—when stacked in large quantities in a damp state, take fire spontaneously. Here the oxidation is merely that of incipient decay or fermentation, which is promoted by the dampness. The confined heat accumulates, as in the case of the oily rags or cotton, until it is sufficient to cause rapid combustion. According to M. Chevalier and others, pulverized charcoal, prepared for making gunpowder and stored in heaps, has been known to ignite, when neither oily nor damp; the very slow action of the oxygen of the air upon the charcoal itself being gradually accelerated by the heat produced until it set it on fire.

Whether grain or seeds of any kind be liable to spontaneous combustion is doubtful; though several French savants came to the conclusion that a barn had caught fire from the spontaneous ignition of damp oats stored in it. But, however, that may be, it will be evident from the facts we have given that many fires, involving great destruction of property, have been the result of spontaneous combustion; and it is probable that many conflagrations ascribed to incendiarism have really owed their origin to the same cause.—*Boston Journal of Chemistry.*

Prof. Huxley's Plan of Education.

I conceive the proper course to be somewhat as follows: To begin with, let every child be instructed in those general views of the phenomenon of nature for which we have no exact English name. The nearest approximation to a name for what I mean, which we possess, is "physical geography." The Germans have a better—*Erdkunde* (earth-knowledge, or "geology" in its etymological sense), that is to say, a general knowledge of the earth, and what is on it, in it, and about it. If any one who has had experience of the ways of young children will call to mind their questions, he will find that, so far as they can be put into the category, they come under the head of *Erdkunde.* The child asks: What is the moon, and why does it shine? What is this water, and where does it run? What is the wind? What makes the waves in the sea? Where does this animal live? and what is the use of this plant? And if not snubbed and stunted by being told not to ask foolish questions, there is no limit to the intellectual craving of a young child, nor any bounds to the slow but solid accretion of knowledge and development of the thinking quality in this way. To all such questions, answers which are necessarily incomplete, but true as far as they go, may be given by any teacher whose ideas represent real knowledge, and not mere book-learning; and a panoramic view of nature, accompanied by a strong infusion of the scientific habit of mind, may thus be placed within the reach of every child of nine or ten.

After this preliminary opening of the eyes to the great spectacle of the daily progress of nature, as the reasoning faculties of the child grow, and he becomes familiar with the use of the tools of knowledge—reading, writing, and elementary mathematics—he should pass on to what is in the more strict sense physical science. Now there are two kinds of physical science: the one regards form, and the relation of forms to one another; the other deals with causes and effects. In many of what we term our sciences, those two kinds are mixed up together; but systematic botany is a pure example of the former kind, and physics of the latter kind of science. Every educational advantage which training in physical science can give is obtainable from the proper study of these two; and I should be contented for the present if they, added to our *Erdkunde,* furnished the whole of the scientific curriculum of schools.

BLACK ink, possessing fluidity, depth of color, and permanency, is still a *desideratum.* The pale inks of the present day, when pure, turn black in time, and are lasting. But the blackness, due to the action of tannic acid in the galls on the iron in the copperas, is inferior in color to the carbon inks of the ancients. A carbon ink of the present day always turns mouldy. What is the secret of making a carbon fluid, free from any disintegrating or perishing ingredient?