Home College Series.

Number ✻ *Twenty.*

THE PLANETS.

BY

REV. C. M. WESTLAKE, M.S.

NEW YORK:
PHILLIPS & HUNT.
CINCINNATI:
WALDEN & STOWE.
1883.

The "Home College Series" will contain one hundred short papers on a wide range of subjects—biographical, historical, scientific, literary, domestic, political, and religious. Indeed, the religious tone will characterize all of them. They are written for every body—for all whose leisure is limited, but who desire to use the minutes for the enrichment of life.

These papers contain seeds from the best gardens in all the world of human knowledge, and if dropped wisely into good soil, will bring forth harvests of beauty and value.

They are for the young—especially for young people (and older people, too,) who are out of the schools, who are full of "business" and "cares," who are in danger of reading nothing, or of reading a sensational literature that is worse than nothing.

One of these papers a week read over and over, thought and talked about at "odd times," will give in one year a vast fund of information, an intellectual quickening, worth even more than the mere knowledge acquired, a taste for solid reading, many hours of simple and wholesome pleasure, and ability to talk intelligently and helpfully to one's friends.

Pastors may organize "Home College" classes, or "Lyceum Reading Unions," or "Chautauqua Literary and Scientific Circles," and help the young people to read and think and talk and live to worthier purpose.

A young man may have his own little "college," all by himself, read this series of tracts one after the other, (there will soon be one hundred of them ready,) examine himself on them by the "Thought-Outline to Help the Memory," and thus gain knowledge, and, what is better, a *love* of knowledge.

And what a young man may do in this respect, a young woman, and both old men and old women, may do.

J. H. Vincent.

New York, *Jan.*, 1883.

THE PLANETS.

In an early age the *planets* were classed among the *stars*. But we have been taught to distinguish the one from the other by the use of the telescope. Stars do not appear enlarged in telescopes of the highest power, only the more intensely brilliant; while planets become greatly magnified, and many of their surface peculiarities visible. The reason is obvious. The stars are at an immense distance from the earth, but the planets are comparatively near neighbors to us, belonging, indeed, to the same family or solar system. Besides this difference in distance, we find all stars are suns, shining by their own light; whereas planets are worlds, such as our earth, and shine simply with the reflected light of the sun. These distinctions between stars and planets were, in the main, unknown prior to the golden age of astronomy, which was inaugurated by the discovery of the telescope. A difference, however, had been observed. Certain stars did not conform to the general order of grouping and motion, but seemed to move in an irregular and uncertain way from one constellation to another. These stars were a source of singular conceits, as well as great perplexity, to early astronomers, who denominated them planets, or wanderers.

Possibly the eccentric behavior of these "wandering stars" was the occasion for the rise of Astrology. The forecasting of events by the aspects, movements, etc., of the heavenly bodies is of remote antiquity. They were early supposed, as the representatives of fortune, to exercise a baneful, good, or mixed influence over individuals and nations. The seemingly arbitrary and irregular movements of the planets could not fail to excite interest, and, doubtless, secured for them the important place which they occupied, among the

heavenly bodies, in this most elaborate and fanciful science of Astrology. While it is now generally conceded that the true theory of the movements of the solar system is of even *more* remote antiquity than astrological superstition, yet the details of *this* superstition are no more complex than the absurd theory proposed by Ptolemy of Alexandria, in the second century, to account for the strange movements of the planets.

I. The Solar System.

Ptolemy's theory was in part anticipated, prior to his time, by many grave philosophers of heathen nations, who reasoned from the sun, moon, and stars rising in the east and setting in the west, that these revolved around the earth as the central world. They regarded the earth as flat, and at rest. They believed the idea of its moving through space to be contrary to the evidence of the human senses. The appearance of comets, meteors, and shooting stars served to strengthen this conviction. However, they realized great difficulty in attempting to reconcile certain astronomical phenomena with this theory. What supports and keeps the earth in its place? was *one* of the perplexing questions, and the occasion of many absurd notions. By some nations it was asserted the earth rested upon the shoulders of a mighty bull; among others, it was said to be supported by a great elephant; while the common notion of the Hindus was that it rested upon the back of a tortoise, and that earthquakes are the result of his changing the foot on which he stands when weary. No attempt was made in these ridiculous and childish theories to explain what supported the animal on which the world rested.

The illustrious Ptolemy, prosecuting his astronomical researches mainly for astrological purposes, maintained, in company with the heathen philosophers, that the earth was the center of the universe, and that all the heavenly bodies

revolved about it in the course of twenty-four hours. He broke with traditionary superstitions, however, in affirming the rotundity of the earth and in approximation to the true idea, which finds expression in the Scripture language of Job—the oldest book in the world—"He stretcheth out the north over the empty place, and hangeth the earth upon nothing." He gave his strange mixture of truth and error a show of reason by affirming the heavens to be composed of a number of moving crystalline spheres, one above another, and in which were fixed the stars, sun, moon, and planets in the order of their nearness to the earth. Every heavenly body, he assumed, moves in an exact circle around a center, and this center in a circle around the earth. This latter circle he called a cycle, and the former an epicycle. To account for the difference of speed in planetary movements, he further assumed the eccentricity of these cycles. All this became the more complicated as the apparent motion of the planets became the more accurately known. Aside from this complex absurdity, Ptolemy made many valuable and abiding contributions to astronomical science. Even *this* theory, so preposterously absurd, obtained as true science throughout the entire civilized world, until Nicholas Copernicus, in the fifteenth century, revived and demonstrated the truth of the Pythagorean theory, that the sun is the center of the system, and the earth, as one of the planets, moves around this center. Before the Ptolemaic era, Pythagoras taught this theory, which was rejected, because unsupported by the requisite mathematical evidence, until the time of Copernicus.

Somewhat after the revival of this Pythagorean theory, Kepler achieved immortality of fame by the discovery of the three great laws governing the motion of the planets, and the necessarily elliptical or oval-shaped orbits of the same. His theory did away with the complicated cycles and epicycles of Ptolemy; but required something additional to

account for the perceptible though slight variations of these orbits from perfect ellipses. This needed addition was realized in Sir Isaac Newton's discovery of the law of gravitation or attraction : "that law which, in its various modifications, gives solidity alike to pebble and planet, and holds pebble and planet alike in place."

"That very law which molds a tear,
And bids it trickle from its source,
That law preserves the earth a sphere,
And guides the planets in their course."

The Copernican theory, thus perfected, reveals the solar system, as connected by the mysterious force of gravitation, with the stars, but existing at the most remote distance from them, and governed by its own physical laws. This theory, with an astonishing degree of accuracy, predicts, for centuries to come, the courses of the planets and their satellites. It makes known the relative positions and importance of the different members of our world-family. The sun—with its dazzling brightness, welcome light, genial heat, evident influence upon animal and vegetable life ; greater mass of matter, 740 times larger than all the planets combined; superior attractive power and repelling force; keeping the planets in their places—as *the great controller*, has the central and most prominent place in this theory, as he has by nature in the solar system. To obtain a clear idea of this system we would continue, as in natural order, with the sun ; but we have already considered that subject in a former article. Certain members of our world-family, such as comets and meteors, we reserve as of sufficient interest for a later article.

The remaining members of our family circle are divided into two general classes : the *planets*, revolving around the sun; and the *satellites*, which, in their turn, revolve around while they accompany the planets in their journey about the

solar orb. The planets, because of their very great difference in size, are called *major planets* and *minor planets*. The latter are frequently denominated *asteroids*, signifying star-like worlds, or, more accurately still, *planetoids*, from their closer resemblance to planets. The major planets are divided by the asteroids into the natural and convenient classification of *the inner group* and *the outer group*. The *inner group* consists of those planets found between the asteroids and the sun. They are as follows, with their *mean distance* in miles *from*, and in the *order* of their *nearness to, the great central orb:* Mercury, 35,800,000; Venus, 67,000,000; Earth, 92,000,000; Mars, 140,900,000. In the same order, those beyond the asteroids, or the *outer group*, are as follows: Jupiter, 481,000,000; Saturn, 882,450,000; Uranus, 1,774,000,000; Neptune, 2,780,000,000.

II. Phenomena of the Planets, which, with various modifications, all have in common.

It is a natural supposition that there is much in our sister planets analogous to what we find over our own globe. But, as a matter of fact, we find greater diversity than similarity. With points of contrast marked and numerous, *all have some features of resemblance.* Yet even these are subject to various modifications, resulting in minor differences and suggesting strange and interesting possibilities. Hence, it is only with *limitations* that we can say the same periodical changes are experienced, the same celestial phenomena are observed, on all the planets, as with us. They have alternation of day and night, of summer and winter. For them the sun has been set to rule the day, and moons and stars to rule the night. But we must remember that the time of revolution of a planet around the sun, whatever it be, is its year, and that of its revolution on its axis its day. We must bear in mind the inclination of a planet's axis to

its orbit determines its seasons. Obviously, the differences in the planets of inclination of axis, orbital and axial revolutions and distance from the sun, carry with them corresponding differences in days and nights, years and seasons. We may get an idea of the relative positions and movements of the planets from the following explanation:

The *apparent* path of the *sun* in the heavens is, in reality, the orbit or path of the *earth*, in its yearly revolution around the sun. This path is called the ecliptic, and its imaginary plane passes through the center of the zodiac, which is sixteen degrees in breadth. The zodiac comprises all the planetary paths; it is the world-path of our system, and extends to eight degrees beyond each side of the plane of the ecliptic. In this world-path—never outside of it—all the planets move from east to west around the sun, except a few of the asteroids or minor planets. The difference between a planet's orbit and the plane of the ecliptic is called its orbital *inclination*. The orbit, or path, of a planet is elliptical, and hence it is sometimes nearer and sometimes farther from the sun. This difference is called the orbital *eccentricity* of a planet. A consideration of these distinctions, in common with a comparison of the several mean distances of the planets from the sun, cannot but prove interesting. It approximates the truth to say, the distance of any planet from the one next to it, and nearer the sun, is but one half the distance to the next planet that is farther from the sun. Perhaps this was nothing more than a singular coincidence, yet, even as such, it required a planet between Mars and Jupiter, where no planet had been found. While searching for it the asteroids were discovered, one after the other, until 225 are now known, with the possibility, as Leverrier affirms, of 150,000 in all. Among these are the only planets whose orbital inclination takes them outside the zodiac. Hence their road-way or zone of space is much wider than that of the larger planets, their orbits

slanting about in different directions in a very complicated fashion. "If a neat model were made of this zone, with a slender piece of wire to represent each orbit, it would be found impossible to lift up one wire without pulling up all the rest." The mean distance of the asteroids from the sun is 250,000,000 miles. Distance from the sun affects axial and orbital motion. The sun's attractive influence diminishes as the square of the distance increases; and we find diminution of orbital velocity corresponding to the sun's weakened force of attraction. The converse of this is also true: great centrifugal—center-fleeing—force is required to counterbalance great centripetal — center-seeking — power. Hence Mercury's orbital velocity must be over 168 miles a minute, or be drawn into the sun; while Neptune, seventy-five times as far off, must move at the modified rate of twenty miles a minute to prevent it from flying beyond the sun's control. Since Neptune is thirty times farther from the sun than we are, the luminary of day must appear there no larger than one of the planets does to us. If it has no other sources of heat and light than those which we have, what a cold, gloomy, cheerless world it must be!—noonday no brighter than our twilight, and the mid-summer far colder than the coldest period of our icy north. On the other hand, the marked eccentricity and the nearness to the sun of Mercury's orbit gives that planet a view of the sun as nine times larger than it is to us, and from which it receives such intense light and heat that—if it ever had any—its oceans, lakes, and rivers must, long ago, have disappeared in vapor. If these planets have animal and vegetable life, in both instances they must exist under far different conditions from those which obtain on our globe. All the other planets lie between these two extremes of orbital velocity, light, heat, and cold, and perhaps bear less resemblance to them than they do in these and other particulars to our own planet. Nearly the same *inclination* of axis is observed in

Earth, Mars, and Saturn; and, in consequence, these planets have very much the same changes of seasons, but differing in the period of time necessary to complete a season. The brilliant white spots at either pole of Mars, supposed by astronomers to be masses of snow, are observed to diminish at the approach of martial summer, and to increase at the approach of winter. These seasons cover a period of time but little greater than our own, while Saturn has seasons seven and a half years long; a polar day of about fifteen years, and a polar night of about the same duration. We do not know the inclination of Neptune's axis; but, if it is like our own, there are at its poles days equal to eighty-two and a half of our years, succeeded by nights of an equal length. An inhabitant there of the average age of man might never see daylight or never see the darkness of night. The axis of Uranus is nearly, if not quite, *parallel* to the plane of its orbit, and therefore its seasons are unknown. Perhaps, to the Uranians, the sun appears to *wind* around their globe in a *spiral* form.

Jupiter's axis is *perpendicular* to the plane of its orbit, and, therefore, this planet has no varying seasons. In the same latitude, at the tropics, it is always summer; at the poles, always winter; and at the temperate zone, always spring. If the great inclination ascribed to the axis of Venus is correct, this planet possesses the most remarkable seasons. For sixteen weeks it presents the south pole to the sun, and for the same period the north pole. And thus in thirty-two weeks its equator has two springs, two summers, two autumns, and two winters; while, in the meantime, its poles have been alternately scorching or freezing. The time of a planet's axial rotation is its day. This time varies with different planets. The difference is so slight between the individual members of either group, that, it is sufficiently correct for our purpose to say, so far as known, they of the inner group rotate on their axes in about twenty-four hours,

and they of the outer group in about ten hours. The effect of this high rate of motion, especially on the enormous bodies of the outer group, is a bulging at the equator, a loss of gravity from centrifugal force, and a shortening of the length of the day—Jupiter's day and night being reduced to five hours each. On the earth the motion at the equator is seventeen miles a minute, which gives it an equatorial diameter twenty-six miles greater than its polar diameter; while Jupiter's equatorial motion is 467 miles a minute, and its polar diameter 5,000 less than its equatorial. Therefore, the oceans of Jupiter, through the simple agency of centrifugal force, are elevated above the common level of other zones—*a mountain of water reaching the astonishing height of* 2,500 *miles.* Before the equatorial velocity of Earth could approach anywhere near that of Jupiter, its oceans would leave the polar regions, rush to the equator, and bury the tallest mountains many fathoms deep, and from increasing velocity would spin off into space, leaving behind a waterless world! Jupiter's superior volume—1,300 times greater, though of less density, than our own planet—is, in a measure, counteracted by the effects of its greater speed of rotation. Yet the distinctions to which the differing sizes of the planets give rise are only slightly modified, not destroyed, by the differences in density of matter and in speed of rotation.

Taking this into consideration, and the law of gravitation, that attraction is proportional to the *quantity* of matter, and varies inversely as the square of the distance from the center of the attracting body, it will be readily seen: the larger the world, the smaller must be its inhabitants, if constituted as they are on our own planet. Hence the inhabitants of Jupiter must be *dwarfs*, of the Earth *men*, and of the asteroids *giants;* while their achievements are in proportion to their size, and inversely to the dimensions of the planet on which they live.

III. Phenomena of the Planets peculiar to each, and presenting Special Points of Individual Interest.

Mercury, in a good telescope, as also Venus, exhibits all the phases of the moon. Though nearly as bright as the star Sirius, it is difficult to see, because of its nearness to the sun and the horizon. For this same reason it is not certainly known if there be, though some astronomers affirm the existence of, a planet between Mercury and the sun which they have named Vulcan. Traces of the most tremendous volcanic action have been discovered on Mercury. Enormous mountains have been observed, one at least ten miles in height, twice that of any known elevation on our globe.

Mercury, and also Venus, at certain stated periods, pass directly between the earth and the sun, and have the appearance of crossing the sun's disk. This is called a transit. One of Venus occurred last year, (1882,) but will not occur again for 122 years. Being used as a means of ascertaining the sun's distance from the earth, the event created, as it always does, a great stir in astronomical circles. The astronomer of to-day, gazing upon this transit of Venus, can say with the young English curate, Jeremiah Horrox, when he witnessed the one of December 4, 1639:

> "We with anxious mind follow thy footsteps here, and far
> As the sight can carry us; my labors now
> Bedeck the monument for future times,
> Which thou at parting left us. Thy return
> Posterity shall witness; years must roll
> Away, but then at length the splendid sight
> Again shall greet our distant children's eyes!"

Venus, the most brilliant of all the planetary orbs, like Mercury, and for the same reason, is seen about sunrise and sunset. At rare intervals she may be seen, with singular and striking beauty, softly shining, while the sun is yet high in the heavens. This fair orb thus appeared when the first

Napoleon was making one of his triumphant entries into Paris, and was hailed by both multitude and conqueror as a significant and pleasing omen. It is possible we never see more than the illuminated atmosphere of Venus; while on Mars, the nearest planet outside the earth's orbit, we can trace with perfect distinctness the outlines of continents and seas. Mars is the reddest star in the heavens. This may be due to its atmosphere, the color of its soil, or the predominant color of its vegetation. Altogether it is, so far as we know, more like our globe than any of the other planets. It may have *sunset* and *sunrise effects* as we have them here: fields wrapped in twilight darkness, soft purple shadows creeping up or down the hills, crags and peaks tapestried with light, and mountain-tops gleaming in silver and gold. It may have the still more glorious *northern lights*, with its infinite variety of form, reaching far above its clouds, and even hundreds of miles beyond its atmosphere. Its atmosphere may serve, as with us, to give additional loveliness to the beautiful in the landscape, the tints of flowers, and the bright plumage of birds. Jupiter is the king planet, because the largest in size. This planet is characterized by the changeful stripes or belts across his disk and the attendance of four satellites, which revolve around it as the moon does around us.

Galileo discovered these moons, but had difficulty in convincing others of their existence, because they persistently refused the use of the telescope. Libri, of Pisi, died still skeptical; and Galileo, in a letter to a friend, expressed the charitable hope that Libri went to heaven by way of the planet Jupiter, and was now convinced of the existence of its satellites. These moons are often seen with a good two-inch telescope. Lunar eclipses are quite frequent, and have furnished the means for discovering the velocity of light. Occasionally several occur at the same time, and present glories of the sky outrivaling our own.

The largest planet except Jupiter, and the *most wonderful*, is Saturn. It is attended by eight satellites, and under the telescope presents the most extraordinary appearance. Around this planet are seen three, and by some five, luminous, concentric, whirling rings, one of which shines with even greater splendor than the planet itself. These rings are very broad and thin, with the inner edge always turned toward the planet's equator, and occasionally the outer edge turned directly toward the earth, in which case they disappear even though our sight be aided by a powerful telescope. Galileo was so amazed at this that he asked, "Is the legend of mythology no longer a fable, and has Saturn really devoured his children?" In attempting to ascertain the nature and origin of these rings, Maupertus suggested the quaint theory that "they might be the mangled remains of an unfortunate comet which had incautiously come too near Saturn, and got his tail wound round the planet and twisted off." The nature and origin of these rings has long puzzled mathematicians and astronomers without very satisfactory results. In beholding thunderous Niagara or towering Alps we experience less of awe and solemnity than we do when, with powerful telescope, we see this strange mechanism of planet, whirling rings and revolving satellites dashing through space at 21,000 miles an hour.

Next in order of distance from the sun is Uranus, for some time supposed to be the outermost planet of our system. It was discovered by Sir William Herschel, whose name it sometimes bears. It has four moons which, contrary to all precedent, move in a retrograde direction, revolving nearly over its poles. The orbit of this planet presented irregularities which for years were unaccountable to astronomers. Bouvard suggested an unknown outside planet. Herschel used the following significant language of a planet beyond Uranus: "We see it as Columbus saw America from the shores of Spain. Its movements have been felt

trembling along the far-reaching line of our analysis with a certainty not much inferior to ocular demonstration."

Adams, of England, and Leverrier, of France, assumed the task of accounting for its perturbations. Each one, by the most extraordinary mental achievements known to the scientific world, succeeded in ascertaining the mass, orbit, and actual position of Neptune before mortal eye ever consciously gazed upon it. This planet was discovered first at Berlin, and then at Cambridge, England, by looking at the place indicated by these men.

How impressively grand and beautiful is the solar system as it appears in a general view! We see its 253 members, all whirling on their axes as they go bowling along their great highway of the skies in perfect harmony and order, and never encroaching the one on the other's domain. We see all these bodies with their intricate movements accompanying the sun in its mighty sweep of 18,000,000 years for a single journey around a far distant and, as yet, scarcely known center. We are overwhelmed by the amazing spectacle; we are awed into silence before a power which no less displays the might of God in swinging the planets than in the activities of living worlds, or the palpitating, struggling, thundering forces on the worlds in process of formation! Yet, in this view, we see only an *infinitesimal part* of God's revelation of his omnipotence and wisdom. Shall we seek a broader range of vision? Before us lies the universe of stars—a universe comprehending such distances and displaying such wisdom and energy as to *far surpass human conception or description.* Of this universe we hope to see and say more in a future paper, and seek now only a brief glimpse as we pass from the present subject.

Neptune has been styled "the last sentinel upon the outposts" of the king of day, who sends his comets as scouts into space *far beyond.* Upon the wings of thought we travel, with the "king's scouts," until they, too, reach their utter-

most distance from the sun, and, feeling the check of his power, curve backward in their course. We borrow the speed of light and continue our journey. From the confines of the solar system we range the unfathomable depths above, beneath, around, and every-where find new worlds. We pass mighty constellations, sweep by huge suns with their planetary worlds, leave millions of stars and hundreds of millions of moons and planets behind, that, traveling at the rate of 185,000 miles per second, it has taken us hundreds of years to reach, and *still find ourselves but penetrating the outskirts of God's universe.*

"Lo, these are parts of his ways; but how little a portion is heard of him? but the thunder of his power who can understand?" (Job.) We will not presume to say, with Kepler, "O God, I think thy thoughts after thee;" but, more modestly, with David, "O Lord, how great are thy works! and thy thoughts are very deep:" "who hast set thy glory above the heavens."

"Enrich me with the knowledge of thy works!
Snatch me to heaven; thy rolling wonders there,
World beyond world in infinite extent,
Profusely scattered o'er the blue immense,
Show me. Their motions, periods, and their laws,
Give me to scan. Through the disclosing deep
Light my blind way."

The Solar System.

"The *sun* revolving on his axis turns,
And with created fire intensely burns;
Impell'd the forcive air, our earth supreme
Rolls with the planets round the solar gleam.
First *Mercury* completes his transient year,
Glowing refulgent with reflected glare;
Bright *Venus* occupies a wider way,
The early harbinger of night and day.
More distant still *our globe* terraqueous turns,
Nor chills intense, nor fiercely heated burns:

Around her rolls the *lunar orb* of light,
Trailing her silver glories through the night.
Beyond our globe the sanguine *Mars* displays
A strong reflection of primeval rays:
The group of *asteroids* in order move
Between the planets *Mars* and mighty *Jove.*
Next belted *Jupiter* far distant gleams,
Scarcely enlightened with the solar beams.
With four unfixed receptacles of light
He towers majestic through the spacious height;
But farther yet the tardy *Saturn* lags,
And eight attendant luminaries drags;
Investing with a double ring his pace,
He travels through immensity of space.
Next, see *Uranus* wheeling wide his round
Of fourscore years; not unassisted found
By human eye; the telescope displays
Him, with six moons, to philosophic gaze.
Still more remote, pale *Neptune* wends his way;
Leverrier's skill divined his distant ray.
His lengthened year, by his slow moving pace,
A hundred sixty-four of ours may trace."

"It is to astronomy we are indebted for our only accurate measures of time. The first period noted by man was, no doubt, counted by days, or *suns*, then by months, or *moons;* after which the apparent annual revolution of the sun gave the idea of a year."—HANNAH M. BOUVIER.

"Blest power of sunshine, genial day!
What balm, what light, is in thy ray!"—LALLA ROOKH.

"Day takes his daily turn,
Rising between the gulfy dells of night,
Like whitened billows on a gloomy sea."—JOANNA BAILLIE.

"These as they change, Almighty Father! these
Are but the varied God. The rolling year
Is full of thee."—THOMSON'S "SEASONS."

"Go! all the sightless realms of space survey;
Returning, trace the planetary way;
The sun that in his central glory shines,
While every planet round his orb inclines;
Then at our intermediate globe repose,
And view yon stellar satellite that glows.
Or cast along the azure vault thine eye,
When golden day enlightens all the sky;
Around, behold earth's variegated scene,
The mingling prospects and the flowery green;
The mountain's brow; the long-extended wood,
Or the rude rock that threatens o'er the flood;
And say, are these the wild effects of chance?
O, strange effect of reasoning ignorance!"—BOYSE.

"The flower that opened its frail beauty within reach of the observer's hand, the wild bird that lifted up its morning song in welcome of the returning light, the evening cloud that curtained the couch of the setting sun with its crimson glory, the rainbow that spanned the pathway of the retiring storm with its sevenfold arch, might indeed for a few moments arrest a more vivid and delighted attention; but when they had finished their brief course and had sunk into silence and darkness, the lifted eye could see the same stars blooming like fire-tinted blossoms on the plains of heaven, undimmed by the darkness of a thousand storms, unchanged by the lapse of a thousand years."—DANIEL MARCH.

THE PLANETS.

[THOUGHT-OUTLINE TO HELP THE MEMORY.]

1. Planets and Stars—Differences? Origin of Astrology?
2. Old theories of Solar System by heathen philosophers? Ptolemy's theory? Copernicus' theory? The "great controller?" Planets? Satellites? Asteroids? Planetoids? Distances from the sun?
3. Phenomena of planets—in common? Some features of resemblance? Cause of day and night? Of seasons? "World-path?" "Orbital inclination?" "Orbital eccentricity?"