ASTRONOMICAL

RECREATION;

OR

A PEEP AT THE

HEAVENS.

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JOHN BETTS, 115, STRAND
(NEARLY OPPOSITE EXETER HALL),

Price 5s. complete.

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BY S. A. E. H.

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Astronomical Recreation.

A KNOWLEDGE of the wonders of the heavens, even if it do not extend beyond the Planets which revolve around our Sun (which combination we call The Solar System) is calculated to impress the minds of young people with the greatness and goodness of the Creator, whose infinite wisdom, power, and love are seen in the manner in which He has been pleased to place each one of those planets under the wonderful laws of motion, which keep it to its prescribed orbit in the heavens.

It is hoped that the present attempt to illustrate this great subject will excite, in those who take part in it, a desire to acquire more knowledge of the subjects thus introduced, and that it will lead them to take an increased interest and pleasure in the sublime study of Astronomy. For this purpose it is much recommended, that the constellations and particular stars noticed in the Game should be searched out in the heavens, and that an astronomical almanack should be procured, by the aid of which the planets may be traced out.

EXPLANATION.

The relative distances of the orbits of the planets are correctly drawn on the accompanying Chart. Uranus and Neptune are omitted, because the introduction of their orbits on the same scale would have inconveniently enlarged the Chart. It is also proper to remark, that the zodiac is not represented on the same scale with the orbits of the planets. But although there is thus an incorrectness in its representation, which cannot be avoided, it is hoped that the arrangement adopted will, nevertheless, clearly impart some important knowledge not often possessed by the young.

It may be desirable to explain, that the stars were at a very early date arranged into divisions called *constellations*, and the Zodiac forms that portion of them through which the planets appear to pass in their revolution round the Sun. They never deviate (except in the instance of the Asteroids) north or south of this belt, which is sixteen degrees in width, and is divided into twelve constellations, in the centre of which is the Ecliptic, an imaginary line which marks the *Earth's* path round the Sun—more com-

monly described as the *apparent* path of the Sun, or the Sun's place in the heavens. The progress of the planets in their revolutions round the Sun can be traced out by the help of those stars which form the zodiacal constellations, as these never change their relative position. But it is to be remembered, that when a planet is said to be near a fixed star, it is so only apparently; and that its seeming nearness is caused by the perspective view of them taken from the Earth, as the gas-lamps in a street may appear to touch each other though separated by a considerable distance. So vast is the distance of the fixed stars from our planetary system, that, by the calculation of astronomers, who have attempted the measurement of them, the nearest is stated to be not less than *twenty billions of miles!*

Astronomers have defined the different apparent sizes of the fixed stars by progressive "degrees of magnitude:"—seven degrees are visible to the naked eye, nine more with the use of the telescope. The stars of largest size are all classed as belonging to the first degree of magnitude; the next smaller, the second degree of magnitude; and so on to the sixteenth. The variation in size is considered chiefly to arise

from the different distances of the stars from the Earth.

It may be well to observe, in explanation of the names by which the planets and constellations are known throughout the world, that astronomy was the study of the ancient heathen philosophers, who called the heavenly bodies after their heathen deities ; and that their names being once fixed, and adopted in all nations, the greatest inconvenience would result from any attempt to alter them.

RULES.

I. The players are provided with representations of the Planets, Satellites, and Fixed Stars,* and with *red* and *white* counters.†

II. The players are to fix on one of their number to preside, who is to read the Book, and take charge of the Counters.

* The Circles with signs attached represent the Planets; the plain Circles represent Moons, or Satellites. The Stars with eight points are Stars of the first magnitude, those with six points are of the second magnitude.

† A *red* counter is considered equal to five *white*.

III. All the Planets, Stars, &c., are to be placed in a small bag; and each player is to draw in turn, and place what he has drawn correctly on the Map.

IV. When a Planet is placed on its orbit on the Map, the President is to read the description of it. When Satellites, or Moons, are drawn, they are to be placed by the side of any Planet having Satellites, until each has its proper number. The description of the Satellites is to be read on placing the first to each Planet. Should a Satellite be drawn before a Planet requiring one is placed on the map, it must be returned to the bag, and the player draw again.

V. When a Fixed Star of either magnitude is drawn, it is to be placed upon one of the constellations of the Zodiac which has a star of its respective magnitude, and which has not been supplied by any previous player. The description of the constellation is to be read when the first star is placed on it.

VI. The player is to receive a *white* counter if he place correctly on the Map the piece which he has drawn; and another for each Answer given to the Questions following the description.

NOTE.—The leader of the game must use discretion in reading any portions of the Appendix. The subjects there treated of being intended for those who are somewhat advanced in their knowledge of the Solar System.

THE SOLAR SYSTEM.

The Sun.

The Sun, the centre of our planetary system, is 882,000 miles in diameter, and could contain within its circumference 130,000 globes as large as our Earth. A fourth part of the Sun's circumference would be sufficient to fill up the space between the Earth and Moon! The nature of the Sun's substance is not ascertained, but as numerous dark spots are visible upon its disc, it is concluded that a solid body exists within a luminous atmosphere. Observations upon them have proved, that the Sun rotates on its axis in 25 days 10 hours. It has also another motion, astronomers having ascertained that the Sun itself travels through space (probably round a centre), carrying with it the whole planetary system, with a velocity of 422,000 miles in a day.

As the young player may not desire to dwell for any time upon this mighty ball of heat, light, and electricity, he may have the pleasure of drawing again.

PRIMARY PLANETS.

MERCURY.

☿ *Orbit No.* 1.

Mercury was, in heathen mythology, the messenger of the gods, and was therefore represented with wings to his cap, and sandals. The planet named after him, being the nearest to the Sun, flies along his orbit with greater rapidity than any of the others, at the average rate of 1830 miles in a minute. The light and heat he receives from the Sun must be intense. The Sun must appear seven times larger than to us, consequently shining with sevenfold brightness; and if the planet's substance be composed of the same materials as the Earth, water would be always at a boiling temperature — nay, even iron brought so near the Sun would be melted.*

* Mercury, from its proximity to the Sun, is rarely visible to the naked eye. The most favourable times for viewing it are in March or April, and again in August or September, shortly before sunrise and after sunset.

As a little visitor from the Earth could not with safety rest a foot upon its scorching surface, the player may borrow Mercury's wings, and fly away to seek a more genial world, by drawing again.

Venus.

♀ *Orbit No. 2.*

This brilliant star may well be named after the goddess of beauty, and be considered Queen among the planets. The diameter of Venus is rather less than that of the Earth; she appears as large as Jupiter, from her orbit being so near to the Earth. Mercury and Venus are called Inferior Planets, because their orbits are within, and consequently smaller than that of the Earth, or of any other of the planets. This is known by these planets only being observed to cross the Sun's disc,—termed a *Transit.* Venus appears in greatest brightness when a morning star, at which time she may occasionally be seen even at noon-day by the naked eye.*

* If the Earth is placed on her orbit on the Chart, an inquiry may be made as to the constellation in which any planet that has been placed in its orbit appears to be, as viewed from the Earth; also, if it is in conjunction with the Sun or in opposition to it? These and many other

When is Venus a morning, and when an evening star?—ANS. *A morning star after her inferior conjunction, when she rises before the Sun, being east of him; and an evening star, in her superior conjunction, when she sets after him, being west of the Sun.*

THE EARTH.

⊕ *Orbit No.* 3.

The representation of the planet on which we dwell, is to be placed upon the Chart in that part of her orbit along which she travels at the commencement of winter (Cancer), when the Sun, it will be noticed, appears to enter the constellation Capricornus. The Earth, like all the planets, is an opaque body, illuminated only by light received from the Sun, which takes $8\frac{1}{4}$ minutes to reach the Earth, although travelling at the amazing velocity of 192,000 miles in a second.*

The Earth, and all the planets, move in their

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elementary subjects may be explained with advantage, if the leader of the game possesses the necessary information.

* See *Appendix* (E.) on Light.

orbits from west to east ; the Earth at the rate of more than 1,000,000 of miles in a day.*

Notwithstanding that the players are at the present time thus rapidly whirling through the heavens, they must endeavour patiently to sit still, and reply in rotation to the following questions ; and for a correct answer each will be entitled to a counter.

What revolution of the Earth causes day and night?—ANS. *The diurnal revolution on its axis.*

By what do we measure our year? — ANS. *By one revolution of the Earth round the Sun.*

In how many days does the Earth revolve round the Sun?—ANS. *In* $365\frac{1}{4}$ *days.*

What causes the variety of the seasons?—ANS. *The Earth's annual motion, in connection with its axis not being perpendicular.*†

What is the Earth's distance from the Sun?—ANS. 95 *millions of miles.*

MARS.

♂ *Orbit No.* 4.

The dusky red‡ appearance of this planet led

* For an explanation of that principle which sustains the planets in their prescribed orbits, see *Appendix* (F.)

† See *Appendix* (C.)

‡ Astronomers attribute its red tint chiefly to the constitution of its atmosphere, combined with a peculiarity of geological construction.

to its being called after the heathen god of war. The planet Mars is about half the diameter of the Earth.

It is to be hoped, that the player who has drawn this planet does not love quarrelling and fighting, lest Mars, provoked, should descend, and carry him off to his blood-streaked planet.

What is the period of his circuit round the Sun?—ANS. *One year and* 10½ *months.*

VESTA.

Orbit No. 5.

Vesta is the nearest of the four Asteroids* represented in the game; all of them are much smaller than our Moon. Astronomers vary in the computation of their diameters, their small size rendering the calculation difficult. Vesta's diameter has been reckoned at only 250 miles. These minute bodies are conjectured to be frag-

* Eleven of these planets have now been discovered. The orbits of the asteroids are called *eccentric*, that of the Earth *concentric*. The former implies deviation from the centre; the latter conforming to a common centre. The distinction may be understood by noticing the difference in the form of these orbits on the Chart.

ments of a larger planet. Sir John Herschel tells us, that the gravity in the asteroids is so small, "that a man placed on one of them would spring with ease 60 feet high, and sustain no greater shock in his descent than he does in leaping a yard from the Earth."

If the Player can tell which of the asteroids was first discovered, by whom, and when, he may receive two counters.—ANS. *Ceres, by Piazzi at Palermo, in* 1801.

JUNO.

 Orbit No. 6.

CERES.

 Orbit No. 7.

PALLAS.

 Orbit No. 8.

JUPITER.

 Orbit No. 9.

Jupiter is the largest of all the planets, and was therefore named after the highest of the deities of the Greeks and Romans. His diameter

is eleven times greater than that of the Earth.* Jupiter's axis is nearly perpendicular to its orbit; hence there can be no change of seasons as with us, or variation in the length of its days. At the equator it is always summer, and at the poles perpetual winter. Jupiter's diurnal motion is very rapid, being performed, notwithstanding his great magnitude, in *ten* hours; consequently the day and night are each five hours in length. The equatorial or central parts of this planet move with a velocity of nearly 28,000 miles an hour, being 3000 miles more in a single hour than the same regions of the Earth move in a whole day. When viewed telescopically, it is found to be surrounded by several dark belts, the precise nature of which is unknown. It is thus represented in the diagram marked **A.**

In how many of our years does Jupiter revolve round the Sun?—ANS. *In eleven years and ten months.*

* The comparative magnitudes of the planets are represented on the diagram marked **A** upon the Chart; to become acquainted with the order of which, the players should recite them simultaneously, beginning with the largest and ending with the smallest.

Saturn.

♄ *Orbit No.* 10.

This planet shines with a dull leaden colour to the naked eye, but can rarely be seen without a telescope, being at so great a distance from the Earth. It is distinguished by a double luminous ring, which must add greatly to the brightness of the heavens as seen from one portion of its surface; but, as this ring shines only with reflected light, it is supposed to cast a shadow, and if so, the Sun must be obscured in that region for the space of 15 years together! The density or weight of this planet is so small that it would *float on water!*

According to the fables of heathen mythology, Saturn was the father of Jupiter and the god of Time. Both these reasons may have led to the planet being thus named, as it was the most distant of them known at that time to revolve round the Sun.

What is the period of Saturn's revolution round the Sun?—Ans. 29 *years and* 10 *months.*

Uranus. ♅

The planet Uranus was discovered by Sir Wm. Herschel in 1781; it sometimes bears

his name, and also that of *Georgium Sidus*, after George III., in whose reign it was discovered. The name of Uranus has been adopted (like the rest of the planets) from heathen mythology, that being the name of the imaginary father of Saturn.

This planet, from his vast distance from the Sun (1,800,000,000 of miles), might be supposed to roll along a dreary course, receiving little light or heat from the Sun if the planet and its inhabitants are of the same nature with our Earth and those who dwell upon it. But to these points, man's knowledge has not attained; and we are not to conclude that the supposed inhabitants of either Mercury or Neptune are in a less favoured condition than ourselves.

Although there is no orbit drawn on the Chart for this planet, the player may yet win TWO *counters by replying correctly to the following questions:—*

What is the supposed period of Uranus' revolution? ANS. 84 *years and one month.*

Is this planet attended by Satellites?—ANS. *It has six Satellites.**

* The Satellites of Uranus differ from all others as respects the position of their orbits, which are nearly perpendicular to the Ecliptic.

Neptune.

This newly discovered planet must not be forgotten by the young astronomer, though no place is assigned to it on the chart.

Owing to its very recent discovery, but little has been ascertained respecting this planet. The observations hitherto made, have led to the supposition that it is attended by many moons, and that, like Saturn, it is encircled by a luminous ring. The existence of this planet bears important testimony to the correctness of astronomical science, its place in the heavens having been determined by mathematical calculations, and observations upon the satellites of Uranus, before the planet was discovered.

What length of time is it calculated that Neptune takes to revolve round the Sun?—Ans. 164 *years and* 9 *months.*

What is the number of primary planets at present known to revolve round the Sun?—Ans. 18, *including the* 10 *asteroids.*

SATELLITES, OR SECONDARY PLANETS.

The Moon.

Of the planets which revolve round the Sun, the more distant are attended by planets smaller than themselves, called *Satellites*, or *Moons*, by which latter name we commonly distinguish the one that accompanies our Earth, and which is carried with it round the Sun. Like the primary planets, they shine by the reflected light of the Sun.* The Moon revolves only once on her axis during her course round the Earth, so that one half of the Moon's disc has never been seen by us. The Moon is considered to be very volcanic. There is no indication of its possessing an atmosphere; from which and other circumstances it is conjectured to be uninhabited.

What period of time does the Moon take to travel round the Earth?—Ans. 29 *days*, 12 *hours*, 44 *minutes, from New Moon to New Moon.*

* The variations in the Moon's shape, or the different *phases*, as it is called, which she passes through in travelling round the Earth, arise from her shining only by reflected light, and from her enlightened parts being more or less visible to us, according to her varied position on her orbit with respect to the Sun and Earth. See *Appendix* (B.), and Diagram **B.**

If the next player can explain the causes of eclipses, both of the Sun and Moon, by placing the representation of the Moon on the Chart so as to show why they occur, and stating at what period of the Moon's age they happen, he may obtain two counters?—ANS. *Eclipses of the Sun are caused by the Moon coming between the Sun and Earth, and can only happen at New Moon. Eclipses of the Moon arise from the Earth intercepting the Sun's rays, and can only occur at the Full, when the Earth is between the Sun and Moon.**

SATELLITES OF JUPITER.

The satellites of Jupiter were not discovered until the year 1610, although the planet itself was known to the ancients.

Observations made at the time of the eclipses of these Satellites, have enabled astronomers to ascertain the velocity of light.

If the player can tell by whom this discovery was made, and what led to the discovery, he may receive a counter.—ANS. *By Galileo the philosopher. The discovery arose from his improvement of the telescope, invented the preceding year.*

* For a further explanation of the Eclipses, see *Appendix* (D.), and Diagram **D.**

SATELLITES OF SATURN.

The discovery of these satellites is of modern date, being so recent as the 17th century.

THE ZODIAC.*

ARIES (*The Ram.*)

The Sun enters this constellation at the commencement of spring, March 24; and the signs which represent this and the following constellation are thought to have been selected as appropriate to the seasons.

Whoever places the first star in Aries must repeat the Latin and English names of the twelve signs, and may receive a counter.—ANS. *Aries, the Ram; Taurus, the Bull; Gemini, the Twins; Cancer, the Crab; Leo, the Lion; Virgo, the Virgin; Libra, the Balance; Scorpio, the Scorpion; Sagittarius, the Archer; Capricornus, the Goat; Aquarius, the Water-bearer; Pisces, the Fishes.*

* See page 4, and *Appendix* (A.)

TAURUS (*The Bull.*)

Can you tell the name of the two noted clusters of stars in this constellation?—ANS. *Hyades and Pleiades.*

GEMINI (*The Twins.*)

Castor and Pollux were twin brothers, according to the fables of heathen mythology; the former famed for horsemanship, the latter as a pugilist.

NOTE.—*As the next constellation* (CANCER) *is without stars of first or second magnitude, the description of it is to be read after* GEMINI.

CANCER (*The Crab.*)

The Sun, having reached the limit of his northern course, when his rays fall vertically or perpendicularly upon that portion of the Earth near the tropic of Cancer, now moves southward. Hence his apparently retrograde path is symbolized by the sidelong motion of the Crab. The Earth being rather more distant from the Sun in this part of her orbit, retards in some degree her progress.

If the player can tell in which season and month the Sun enters Cancer, and also show the Earth's

place in its orbit at that time, he is entitled to two counters.—ANS. *On the 21st of June, which is the commencement of our summer season, when the Earth enters the constellation Capricornus.*

LEO (*The Lion.*)

It is conjectured that the power and fierceness of this animal denote the strength of the Sun's heat at the season of the year in which he enters this constellation.

The players are recommended to search for this brilliant constellation in the heavens during the month of March, when it may be seen to advantage about nine o'cloch, towards the eastern part of the sky.

VIRGO (*The Virgin.*)

Virgo is represented with a sickle and ears of corn, emblematical of the harvest season. This is a bright constellation for the young astronomer to seek out in the month of May, in a S.S.E. direction.

What is the difference between the fixed stars and the planets?—ANS. *The fixed stars are luminous bodies like the Sun, and do not change their relative position. The planets (wanderers) shine from the reflected light of the Sun and revolve around him, forming what is called the Solar System.*

LIBRA (*The Balance.*)

From the Earth's position in relation to the Sun when the latter enters this constellation, there is equal day and night all over the world, which is represented by a balance, or scales.

If the player can tell what part of the Earth is opposite the Sun, to occasion this even distribution of light, and at what periods of the year it occurs; two counters are to be awarded.—ANS. *The Equator;—it occurs in March and September, the time of the equinoxes when the Sun's rays extend to both the poles of the Earth.*

SCORPIO (*The Scorpion.*)

The sign Scorpio is supposed to denote the prevalence of sickness and death in the autumnal season, when the Sun apparently passes through this constellation. This constellation is a very brilliant one, and may be seen in the midnight heavens about June or July.

NOTE.—*As the four following constellations are without stars of either first or second magnitude, the description of those signs is to be read, and notice taken of their situation in the zodiac upon the Chart.*

SAGITTARIUS (*The Archer.*)

It is conjectured, that the commencement of the season suitable for the chase, is denoted by this fabulous representation of an archer, called a Centaur by the ancients.

CAPRICORNUS (*The Goat.*)

The Goat, which delights to climb high mountains, is supposed to be an emblem of the winter solstice (Dec. 21), when the Sun enters this constellation, and his vertical shining has reached its southern limit, and he begins to rise to the inhabitants at the arctic circle.

If the player, whose turn it is, can tell the position of the north and south poles of the Earth, in relation to the Sun, at this period of the year, he may receive a counter.—ANS. *The north pole declines from the Sun, the south pole inclines towards it.*

AQUARIUS (*The Water-Bearer.*)

The constellation to which our attention is now called, is represented by an imaginary figure of a man pouring out water from an urn; an emblem of the rains of the winter season, when little boys and girls must often content themselves with in-door amusements.

PISCES (*The Fishes.*)

This sign is supposed to be an emblem of the fishing season. The ice being broken up, the fisherman plies his work diligently in the seas and rivers.

COMETS.

The representation of the comet's orbit on the Chart describes the very elliptical and eccentric form their orbits universally take ; their course at some periods approaching the Sun, and at other times being removed out of our sight, beyond the farthest planet. When they cross the Sun's disc, no black spot appears, as in the transit of Venus, which rather proves them to be illuminated bodies. When in that part of their orbit nearest to the Sun, comets are commonly accompanied by long trains of luminous vapour, emitted from the head, or nucleus, probably through the action of the Sun. The Comet seen in 1680 had such an extensive train, that when its head was in the horizon its train reached the zenith. The motions of comets are but little understood, and the periods of their revolutions very difficult to ascertain. Professor Halley predicted with considerable accuracy respecting the return of the

comet seen in 1682, which accordingly appeared in 1759, after a revolution of about seventy-six years, and again in 1835. Dr. Halley considered it was the same comet that had appeared in 1607 and in 1531.

The appearance of comets has been registered as far back as the year 130 B. C.; and more than 700 have been noted since the Christian era.

SOLAR SYSTEM.

Names and Orders	No. of Satellites	Diameter.	Distance from the Sun.	Period of Revolution.
☉ Sun	...	882,000		Days. Hours.
☿ Mercury ...	...	3140	37,000,000	87 23
♀ Venus	...	7800	69,000,000	224 16
⊕ Earth	1	7926	95,000,000	365 6
				Years. Mnths. Days
♂ Mars	...	4100	145,000,000	1 10 15
Flora	...	209 ?	209,000,000	3 3 8
⚶ Vesta	...	250 ?	224,000,000	3 7 15
Iris	...	...	226,000,000	3 8 6
Metis	...	...	227,000,000	3 8 10
Hebe	...	...	230,000,000	3 9 15
Astrea.....	...	...	245,000,000	4 1 21
⚵ Juno	...	79 ?	255,000,000	4 4 14
⚳ Ceres	...	163 ?	263,000,000	4 7 12
⚴ Pallas.....	...	...	263,000,000	4 7 16
Hygeia	...	...	297,000,000	5 6 19
Victoria ...				
♃ Jupiter.....	4	87,000	494,000,000	11 10 17
♄ Saturn.....	7	79,150	906,000,000	29 6
♅ Uranus.....	6	34,500	1,800,000,000	84 1
♆ Neptune ..		41,500	2,900,000,000	164 9

Doubtful.

FIXED STARS.

OF THE FIRST MAGNITUDE.

Star.	Constellation.	Position.	Period of coming to Meridian at nine o'clock.
Aldebaran ...	Taurus ...	Head	January 10.
Castor	Gemini ...	Head	February 24.
Regulus	Leo	Shoulder	April 6.
Spica Virginis	Virgo	Ears of Corn	May 23.
Antares	Scorpio ...	Back	July 10.

OF THE SECOND MAGNITUDE.

Pollux	Gemini ...	Head	February 24.
Denebola	Leo	Tail	May 3.
Algieba	Leo	Neck	
Zubenescha-male (α).....	Libra	Left Scale ...	
β Scorpio.....	Scorpio ...	Head	
α Arietis	Aries	Right Horn	December 5.
β Tauri	Taurus ...	In the Horn	

APPENDIX.

(A.)

THE STARRY UNIVERSE.

Beyond and all around our Solar System lies the unmeasured region of the stars. Those planetary worlds, which revolve around the same Sun as our Earth, although of vast interest and importance to ourselves, occupy but a small space in the grand expanse of the Universe. When we look upon the heavens on a clear night, and see them glowing with innumerable brilliant stars, the eye may rest upon one, or possibly two, which belong to our system, and are planets illuminated by the Sun; but the vast number we behold are distant suns, shining by their own light,—called "Fixed Stars," because, although they are not stationary, yet they do not change their relative positions, whereas the planets (or, as the word implies,

wanderers) revolve round the Sun, apparently passing through the zodiacal constellations.

From whatever quarter of the world we regard the heavens, they are equally resplendent with radiant orbs, many of them larger than our Sun; and judging, as we may be permitted to do, from the infinite wisdom displayed in the creation of our own world and the system of which it is a part, we are led to conclude that each of these suns enlightens planetary and habitable worlds which revolve round them. Thus the universe is teeming with life. Truly, "the heavens declare the glory of God, and the firmament showeth his handywork."

But, beautiful as the clear midnight heavens are to the naked eye, their dazzling splendour and immensity become infinitely more developed by means of the recently increased power of the telescope, whereby large fields of stars have been discovered, where before appeared only a mysterious light. By laborious telescopic examination of the heavens, astronomers have come to the conclusion, that the stars are not scattered through space without plan or connexion with each other, but that they are arranged in combinations more or less extensive, and that our own planetary system forms only a

part of one grand cluster of stars. That luminous zone, which is known by the common appellation of the *Milky Way*, is considered to be the outer boundary of our cluster. The luminosity of its appearance in the heavens arises from its being composed of myriads of stars, too distant to be clearly distinguished from each other by the naked eye. The telescope leads to the conjecture, that thousands of similar galaxies are distributed through the far heavens. And within these larger combinations, smaller groupings are observed, so that the universe is formed of systems within systems, each, it is conjectured, united by the force of attraction, and revolving round centres, while the whole mighty combination of systems is in motion also. Of the smaller groupings it is discovered that some consist of four, others of three, and others of two stars revolving round each other; these are distinguished by astronomers as quadruple, triple, and binary systems. Their periods of revolution vary from 100 to 10,000 years. From very careful observation, astronomers have concluded that many of these stars shine in the varied hues in which they appear to us. In the clear atmosphere of the East, the diversified light which is emitted from the stars is more

plainly manifest. The most striking variety of colour among the stars appears in the following, of the first magnitude: Sirius, Vega, Altair, and Spica, shine with a very bright *white* light; Aldebaran, Arcturus, and Betelgueux, have a *red* tint; Capella and Procyon give forth a *yellow* light. What variety of illumination and beauty may be the result, where two or more suns shine upon their surrounding regions with diversified colours, sometimes their rays blending together, and at another time the absence of one of the luminaries causing the prevailing light to be blue, or some other colour!

Yet further to unfold to the young enquirer, the fathomless expanse of the mighty universe, spread out in the far distant heavens, we will give a moment's consideration to those bright clusters of stars called *Nebulæ*, which appear only as misty spots to the naked eye, but through telescopic power are made known to us as vast assemblages of glorious orbs. In those remote depths of space, the stars that glitter in our heavens may be scarcely visible; but the midnight skies of some of those regions which the telescope makes known to us must present a brilliancy immeasurably beyond our own.

But although the telescope has accomplished much, in not only disclosing the nebulæ to be clusters of stars, but also in bringing to light hidden clusters, which, from their infinite remoteness, were previously unknown, yet there are still innumerable bright spots throughout the heavens, and depths in that luminous girdle, "The Milky Way," which the most powerful telescope has not yet fathomed. Their glimmering light, newly brought within our vision, emphatically tells of the further stretching out of infinite space, beyond the power of man adequately to comprehend, and fills the mind with profound admiration and wonder, when reflecting on the Infinite Source of All, who upholds these myriads of glowing suns, and has distributed them with consummate skill throughout the stupendous universe.

With a view of placing more clearly before the young inquirer the theory now received respecting the nearly circular cluster of stars in the zone of which our system is placed, it may further be observed, that the number of stars increases in proportion to their greater distance. For instance, there are infinitely more stars of the eleventh magnitude than there are of the first; and when we reach the eleventh order,

the stars are noticed to crowd towards the Milky Way, or are positively within that zone, whilst, throughout the other districts of the sky, stars of this magnitude are no longer numerous. And as regards still smaller stars, they seem literally absent from all parts of the sky, excepting along this stream of light, where they exist in incredible numbers,—not distributed in unbroken uniformity, but arranged, as the telescope developes, in irregular successive groups, the intervals being occupied by more scanty distributions of stars. In Sir W. Herschel's examination of the bright spot in the sword-handle of the constellation Perseus, his ten-feet telescope opened to view stars which he considered to extend to the 344th order of distance—a space so vast, that light requires upwards of 3,000 years to traverse it!

To render the arrangement of the stellar universe a little more familiar, we will imagine the young inquirer to take a long flight from the Earth to view these glorious and wonderful works of creation. Crossing the path of the two inferior planets, you would alight upon the Sun; and here you behold all the planets rolling in silent grandeur around you; but you find the very sun on which you stand

to be moving, travelling around another sun in the distant view, carrying the planets with it in its mighty sweep. To this sun you wing your way, around which you see some rolling planets, and far away the solar system you have left, slowly moving in its majestic orbit around you. But this sun, too, is in motion round another one, and to that central sun you wend your way, and from thence behold these two great solar systems rolling around you; and so you pass from sun to sun, and find them all in motion. But a region of splendid hues attracts your eye. You soar away to it, and two suns of varied colours are revolving round each other, the one sending forth rays of yellow light, the other blue, their mingling hues irradiating the worlds they enlighten with a brilliant green. After pausing awhile in profound admiration, you take to wing once more, and find yourself on the limits of this great assemblage of systems—the *Milky Way;* then you are confounded with the magnificence of a vast extended universe, occupied with similar grand combinations of clusters of stars; and possibly behold the whole universe in complex and wondrous motion round a centre that cannot be penetrated!

The subjoined table, from Nichol's Architecture of the Heavens, shows the distances of nine different magnitudes of stars, and the time their light takes in reaching us. The measurement is given in radii of the Earth's orbit (the radius being 95,000,000 of miles), as conveying a less confused idea than if such great distances were stated in miles.

Apparent Magnitudes.	Distances of the Stars, expressed in radii of the Earth's orbit.	Number of Years occupied by light in traversing those distances.
1	1,246,000	19
2	2,111,000	33
3	3,151,000	49
4	4,375,000	69
5	6,121,000	96
6	8,746,000	137
7	14,230,000	224
8	24,490,000	386
9	37,200,000	586

(B.).

PHASES OF THE MOON.

The various changes of the Moon's appearance may be readily understood by a little studying of the diagram marked (**B**). The Moon being an opaque spherical body, like all the planets, and it being only possible for the Sun to illuminate the half of any sphere at a time, it follows, that when she is in that part of her orbit which is nearest to the Sun, the whole of the Moon's unenlightened or dark side is towards the Earth, and consequently she is invisible to its inhabitants; although the Sun illuminates at all times half her surface, as represented on the diagram by the outer circle of globes. As the Moon emerges from this position, her illuminated surface can only by degrees become visible from the Earth, presenting on her first appearance the form of a very thin crescent, the projecting or convex side being towards the Sun. When the Moon is in this part of her orbit, she is said to be in *conjunction*, and she commences her month, and we call it New Moon. As the Moon advances in her orbit, the bright crescent becomes broader; the points (or horns, as they are called) are always turned away

from the Sun ; and when she has performed one fourth of her circuit, she exhibits one half of her enlightened surface, and this appearance is called her First Quarter. Proceeding on in her course, the part illuminated by the Sun becomes more and more visible to the earth, and we have a three-quarter moon presented to us, when she is said to be *gibbous*. The next stage brings her to the most distant part of her orbit from the Sun, when she is said to be in *opposition*, and the Earth being between the Sun and Moon, her whole enlightened hemisphere is seen by us, and then it is Full Moon. Having traversed one half of her orbit, the Moon, in completing the rest of her course, necessarily passes through the same variations of appearance ; her enlightened surface becomes less and less turned towards the Earth, and she decreases from full moon to gibbous, then to half moon, when she is said to be in her Last Quarter ; she then assumes her crescent form, and finally, at the end of her revolution, disappears, preparatory to her coming forth as a New Moon again. From this it will appear, that it is not the shadow of the Earth thrown upon the Moon that causes her appearance to vary ; but her globe being opaque, and lighted up by the Sun, only portions of her

illuminated sphere are turned towards the Earth, excepting when she is in opposition to the Sun, and we see her whole illuminated disc, as at full moon.

(C.)

THEORY OF THE SEASONS, AND LENGTH OF DAYS.

Some of the young astronomers engaged in this game may be desirous of understanding more clearly, why it is that we have long and warm days in summer, and short and cold ones in winter.

The grateful variation of the seasons which successively visit the different latitudes of the Earth's surface, communicating important blessings to its inhabitants, depends upon the longer or shorter space of time that the Sun enlightens any region during the 24 hours in which the Earth makes one turn on its axis, and which is called its *diurnal* rotation. Our attention ought, therefore, first to be given to the cause of the days varying in length.

Referring to the diagram (**C**) on the chart, it will be observed, that the Earth is represented as she is situated with respect to the Sun in four periods of her annual course, marking the four

seasons of the year. That representation of the Earth in which the north pole is turned towards the Sun, describes her position in the month of June, which we will consider first; when, in Great Britain and in all countries of the same latitude, the days are at their greatest length. It will be understood, that that part of the globe which is represented dark, marks the duration of night in the different latitudes of the earth; and it will be noticed, that in this figure of the Earth, the northern hemisphere (or that half of the world which is north of the equator) is more enlightened by the Sun than the southern hemisphere; and that the enlightened portion of it, especially in the latitude of Great Britain, is much greater than that which is turned away from the sun, and is consequently in darkness. According to this proportion of light and darkness, as drawn on the diagram, is the length of the day and night. Where two-thirds of the hemisphere are shewn to be enlightened, the day is sixteen hours long, and the night is but eight hours. The reverse takes place, as regards our latitude, when the Earth is in the opposite part of her orbit, as represented in December on the diagram; the broad shadow indicates that that portion of the earth is two-thirds of the 24 hours

in darkness, the days being then but eight hours in length.

We have further to consider why this part of the world is so much enlightened, or has such long days in the month of June. If the young enquirer has not already found out the reason, he will perceive that it is caused by the inclination or slanting of the Earth's north pole towards the Sun when in this period of her annual course. The supposed axis on which the Earth diurnally rotates, is inclined $23\frac{1}{2}^{\circ}$ from a line perpendicular to its orbit; that is, it revolves round the Sun in a slanting position. The Sun always illuminates one half of the globe, his rays of light extending 90° in every direction; it follows therefore, that when the north pole inclines towards the Sun, and his rays necessarily extend beyond it, he must withdraw his shining exactly the same number of degrees from the south pole. The polar circles, called *arctic* and *antarctic*, mark the boundary of those regions where the Sun at certain times is visible for 24 hours and more to their inhabitants, and is distant from the poles $23\frac{1}{2}^{\circ}$, the same number of degrees that the Earth is inclined from the perpendicular. The long day of six months commences at the north pole in March, and

diminishes in proportion to the greater distance of the place from the pole. When our northern hemisphere thus, as it were, leans towards the Sun, the latitude of Great Britain is brought, not nearer to the Sun, but nearer to his vertical or perpendicular rays, causing the Sun to rise to a higher altitude above the horizon ; that is, to the countries in our latitude he makes a higher arch in the heavens, which therefore gives us a longer day. It is to be remembered, that just in proportion to the lengthening of days and increase of light and heat, from March to June, in the northern hemisphere, they diminish from the equator to the south pole, where the Sun is never visible from March to September.

We have now seen what occasions the light of the Sun to remain longer with us at some periods than at others ; we also know, that the longer the day is in any portion of the globe, the warmer is the season ; it is therefore very manifest, that the inclination of the Earth's axis is as important a cause of the variety of the seasons, as her revolving round the centre of light and heat.

Another provision, of equal importance, is that of the poles of the Earth always maintaining their north and south direction in the heavens.

We will now follow the Earth through the

different seasons of her annual revolution, noticing how completely all parts of her surface are successively turned towards the Sun, to have their appointed share of his warm and enlightening rays. How full of infinite wisdom is the simplicity of the arrangement which causes such beneficial and grand effects !

We commence with our season of Spring ; and the young inquirer's attention is called to the representation on the diagram, where the Earth is wholly enlightened from pole to pole, showing her position on the 19th of March. The Sun's rays at this period fall vertically upon the centre of the Earth's surface, that is, on the countries at the equator. As they always extend 90° in every direction, the light is dispersed from pole to pole, and all parts of the world have the same length of day and night, each being of equal duration. The countries at the equator have at this time their hot season ; and the degree of heat and light diminishes equally towards both poles, according to the distance from the equator, which causes the season in our latitude at this period to be of a temperate character. The Earth continues its course from east to west during April, May, and June ; and the warm season advances in our

northern latitudes, by the poles preserving the same parallel line, and by the inclination of the north pole being gradually brought in the direction of the Sun, causing the vertical rays of the Sun to advance over the countries north of the equator till they are distant from it $23\frac{1}{2}^{\circ}$, which is the northern boundary of his perpendicular shining. This is marked on a globe by an imaginary circle, called the Tropic of Cancer. It will appear, then, that when the Sun's rays are vertical at the tropic of Cancer, they more nearly approach to being vertical in the latitude of Great Britain than at any other part of the Earth's annual revolution ; and this is an additional cause of the warm weather of our summer.

Perhaps it is scarcely necessary to observe, that wherever the Sun shines vertically, or directly opposite to a place, there must be the greatest heat,—his rays coming with more force and also in greater number ; and the more they descend aslant, the fewer are the rays, and the less heat and light are communicated. Light proceeds from the Sun in rays of direct lines, and our earth being of a globular form, though not a perfect sphere (for the diameter from pole to pole is shorter by 27 miles than the diameter

at the equator), this curved surface of the Earth must cause the Sun's rays to descend upon the Earth for the most part, in an oblique or slanting direction. His vertical shining is confined to that part of the globe within $23\frac{1}{2}^{\circ}$ north and south of the equator, the limits of it being distinguished by the tropics of Cancer and Capricorn, the Sun successively becoming vertical to the countries situated in those latitudes. As the Sun is never vertical north of the tropical line of Cancer, his light and heat must *always* descend slantingly upon Great Britain; but when he shines, as he does in June, vertically over the countries $23\frac{1}{2}^{\circ}$ north of the equator, his rays descend less obliquely upon the inhabitants of our latitude, and therefore come with increased number and with greater force. When the Sun has reached the tropic of Cancer on the 21st of June, called the Summer Solstice, his permanent light around the north pole has traversed its utmost extent, and all the inhabitants within the region of the arctic circle have continual day, and their warmest season.

The Earth rapidly passing on in her orbit, the north pole will necessarily take a different position as respects the Sun, and the Sun's light and heat will be drawn away from the northern

regions, and his vertical rays leave the tropic of Cancer, and travelling south, will pass over the same countries until they are again perpendicular to the equator on the 24th of September. The countries at the equator have now a second warm season, and the Earth presents her full side view to the Sun, as in the month of March. The day and night are again of equal length in all latitudes. So horizontal to the Sun's rays, is the position of the Earth's surface at the poles, that he takes three days to rise at one pole while he at the same time sets to the other; half of his disk being above the horizon, and visible at both poles on the day of the equinox. Although the Earth, from June to September maintains the same successive positions with respect to the Sun as she does from March to June, yet the latter period is the warmest in the northern hemisphere, because the great increase of heat, imparted by the Sun to this portion of the globe during the long days, is retained by the Earth, and slowly evaporates through the autumn season, as the nights increase in length.

The Earth has now performed half her annual journey, and the northern hemisphere has had the largest share of the Sun's vivifying rays. With precision she speeds along her course from

September to December, to fulfil her appointed annual work. The duty now before her is to present the southern hemisphere to the Sun, that it may receive an increased portion of light and warmth from his rays; and the region of the south pole, where the Sun has been altogether obscured for six months, begins to partake of his light, and he rises to its inhabitants, not to set for six months.

The Earth, steadily preserving the position of her axis, necessarily brings the countries south of the equator under the vertical influence of the Sun, and long days and the warm season gradually approach the countries beyond the tropic of Capricorn, according to their distance from the equator; while, north of the equator, the Earth's inclination causes her north pole to be more distant from the Sun, the nights therefore increase in length, and the Sun's rays are becoming more and more slanting to the countries in the latitude of Great Britain, and almost horizontal within the Arctic circle, where for a time he will only rise to travel round the horizon.

On the 21st of December (called the Winter Solstice) the Sun shines vertically at the tropic of Capricorn; the antarctic regions are then receiving their largest benefit from the Sun, the

north pole directly declines from him, and the shortest days and coldest season visit the northern hemisphere.

It has been decided, from two facts, that the Earth approaches a little nearer to the Sun in this part of her orbit, causing her course not to be quite circular. 1st, She is shorter by eight days in passing from September to March, than from March to September. 2dly, The Sun's apparent diameter is greater in the winter than in the summer.

The Earth proceeds to complete, in three more months, her revolution round the Sun; his vertical rays have reached their southern boundary, and from the 21st of December begin retracing their steps towards the equator, and shining with increasing power over the same countries, till we arrive at the month of March, when the Sun is vertical at the equator, and the Earth has finished one revolution round the Sun, a distance of about 600 millions of miles, performed during $365\frac{1}{4}$ rotations of the Earth on her axis.

It is hoped that the young student is now prepared to answer all the enquiries of his younger friends, as to why the days are long and the seasons warm at one period, and short and cold at another.

(D.)

ECLIPSES.

Eclipses of the Sun are caused by the Moon passing between the Sun and the Earth; she being an opaque body, with no light of her own, intercepts the rays of light from the Sun, and casts her shadow upon one particular part of the Earth. As the Moon is the smaller body, she could not overshadow the whole Earth.

Eclipses of the Moon are occasioned by the Earth coming between the Sun and the Moon; and as the Earth is an opaque body, she also must obscure the light of the Sun, and create a shadow called the *penumbra*, through which the Moon in certain positions on her orbit has to pass, and becomes eclipsed to all parts of the Earth.

An eclipse of the Sun can only take place when the Moon is in conjunction with the Sun, or at the time of New Moon, as it is only then that she passes between the Sun and the Earth. But the young inquirer may wish to ask, Why have we not a solar eclipse every month at the time of New Moon? This does not occur,

because the orbits of the Earth and Moon are not on the same plane or level with each other; the Moon's orbit is oblique to that of the Earth. If both spheres traversed their course on the same horizontal level with each other, we should have a solar eclipse at every new moon, and a lunar eclipse at every full moon. But, from this oblique crossing of the two orbits, the Moon generally, at the time of new and full, passes either above or below the horizontal plane of the Earth's orbit, and therefore does not intercept the light of the Sun. As the Earth and Moon move on in their respective paths, the oblique form of the Moon's orbit causes her exact position, with respect to the Sun and Earth, to vary each month, and at certain times the Moon is brought in conjunction with the Sun, or the new moon occurs, when she is near to that part of her orbit which crosses the Earth's path, called the *nodes* of their orbits. This position places the Sun, Moon, and Earth, in a direct horizontal line with each other, and an eclipse of the Sun takes place. The extent of an eclipse depends upon the nearness of the nodes at the time of conjunction; and when the conjunction takes place precisely at the nodes, there is a ***total*** eclipse.

Eclipses of the Moon can only happen at the time of full moon; and depend, like the solar eclipses, upon the Moon being in opposition (that is, at her full), when she is in or near to the nodes, where the orbits of the Earth and Moon cross.

Astronomers calculate exactly when eclipses are to occur, and the length of their duration. The duration of a total solar eclipse can never exceed 7′ 58″, nor that of a lunar eclipse $5\frac{1}{2}$ hours, being totally eclipsed for only $1\frac{3}{4}$ hour. The usual number of eclipses annually is four—two of the Sun, and two of the Moon. How great are the advantages we reap from learning and science, by which means such accurate knowledge has been obtained, while barbarous tribes regard this natural phenomenon with alarm and superstition!

(E.)

LIGHT.

The theory respecting the nature of Light is a subject of much interest. It is considered to proceed from the Sun in direct lines of rays; and, from astronomical observations upon the eclipses of Jupiter's Satellites, it is ascertained,

not to be emitted instantaneously from any body, but successively propagated, travelling at the velocity of 192,000 miles in a second. It therefore takes $8\frac{1}{4}$ minutes to pass from the Sun to the Earth ; consequently, were the Sun suddenly extinguished, we should not be conscious of the fact till the expiration of that time. The planet Neptune is thirty times farther than we are from the Sun, and a beam of light must occupy four hours in passing from the Sun to that distant sphere. Light is of course still longer in its transit from the fixed stars to our Earth ; for instance, when our eyes rest on stars of that first magnitude, which are the stars nearest to us, we are looking on them as they were six, ten, and thirty years ago ; and from the smaller stars, which are those at a greater distance, the beams of light must have left those orbs, in some cases, hundreds of years, before we see them ; and our planetary system might be blotted out, and the occurrence unknown for ages in the remote regions of the universe.

Although light proceeds in direct rays, yet when it reaches the atmosphere of our Earth, which is not more than fifty miles high, they undergo successive reflections or bendings, from the density of the medium, and at length come

to the Earth's surface in curved lines, and consequently in diminished power. The Earth's atmosphere is more dense near to the surface, and gradually becomes lighter and purer in the higher regions of it; light therefore becomes more and more refracted, the nearer it approaches the Earth; it results from this, that we never behold any of the heavenly bodies in their true positions, except when in the zenith, as for example, when the sun is seen to be just resting on the horizon, it is in reality altogether *below* it, and these refractions also cause the blue colour of the sky, the orange tinge of the morning and evening, and the ruddy hue of the heavenly bodies when seen near the horizon. The power our atmosphere possesses of reflecting the Sun's light, gives to us the benefit of twilight, thus prolonging our light, though in a subdued degree, until the Sun has reached 18° below the horizon; and in the same manner his rays light up our atmosphere prior to his rising, and we have the enjoyment of the morning's dawn.

It has been stated that light proceeds in distinct rays from the Sun. Each white or colourless ray is composed of three original, or seven combined, colours—red, orange, yellow, green,

blue, indigo, and violet. These are all displayed in the rainbow. That beautiful arc, which is never seen but in rainy weather, is caused by the rays of light falling on the drops of rain; where, by refraction and reflection, they are separated into these colours. The same effect may be produced by passing the rays through a glass prism. It is by the *reflection* of rays that substances receive their colour. Bodies do not possess any colour in themselves, but have various powers of reflecting and absorbing the light they receive. When portions of a ray are absorbed, the light reflected upon the substance may be blue or any other colour; when all the colours are reflected, the appearance is white; and when all are absorbed, it is black.

(F.)

WHAT KEEPS THE PLANETS IN THEIR ORBITS?

The Creator of our magnificent Universe, from whom all life and motion proceed, has endowed the heavenly bodies with a property even more marvellous than the beauty of their exterior frame. This principle is called *gravitation*, and

by its power the planets are sustained in their respective orbits. The *fixity* of their path through the heavens arises from the perfect balance between the attractive force of the Sun and the power the planets possess of flying off from this centre of attraction: the former is called the *centripetal* force, and the latter the *centrifugal* force. This double action, impressed upon the planets and the Sun, causes them to maintain their place as they revolve round him, in a somewhat similar manner to that with which a ball, whirled round by a string, preserves an exact circular line. It must further be recollected, that the planets are at various distances from the Sun, and that their gravitating power is made to differ accordingly. How infinite is the wisdom here manifested in ordaining such beautiful adjustment of these two propelling forces! A very slight deviation in the velocity of a planet might either cause it to whirl away into infinite space, or to be drawn into, and absorbed by, the Sun.

As respects the nature of the Earth itself, there exists the principle of *gravity* within its centre; by which, in the first place, all the particles of which it is composed are attracted in masses; and secondly, all bodies on the Earth's

surface are firmly attracted to it, so that they cannot fall off, notwithstanding the velocity of the Earth's motion ; and all bodies thrown off from the Earth, by whatever force, must return to it again. For instance, to whatever distance a cannon ball could be sent upward, it would fall again to the Earth. But supposing that at the end of its flight, a power intervened to prevent its return, the attractive force of the Earth would cause it to travel round the Earth, in perpetual revolutions. It is the same principle of attraction that causes the Moon to revolve round the Earth, the Earth from its proximity having a stronger influence than the Sun. The Moon also has a considerable influence over the Earth, and it is the chief cause of the flux and reflux of the tides.

THE END.

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