IRVING'S

ATECHISM

OF

Astronomy;

CONTAINING THE

MOTIONS, MAGNITUDES, PERIODS, DISTANCES,

AND OTHER PHENOMENA

OF THE

HEAVENLY BODIES.

Founded on the Laws of Gravitation.

WITH ENGRAVED ILLUSTRATIONS.

FIFTH AMERICAN EDITION, REVISED AND IMPROVED,

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Adapted to the Use of Schools in the United States.

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PREFACE.

The long established reputation of Irving's Catechisms precludes the necessity of adding any comments on their merits. The very extensive circulation which they have had, not only in England, but also in this country, is the best proof of their utility. The plan of his works is the very best that could be adopted. The catechetical form of instruction is now admitted, by the most experienced teachers, to be the best adapted to the nature and capacity of youth ;—a system by which children will acquire a knowledge of a science in less time than by any other.

The present number on Astronomy will be found to possess peculiar merits. It is admirably adapted to that class of learners, for which it is designed. It presents, in a few words, to the mind of the pupil, the most important and most interesting points in the study of the science.

The present edition has been carefully revised, and considerably improved. These improvements, it is believed, will add much to its merits, and render the work still more worthy of that liberal patronage, which has already been extended to it.

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Catechism of Astronomy.

INTRODUCTION.

Laws of Motion, Gravitation, Centripetal Force, and Centrifugal Force.

MOTION.

Q. WHAT is Motion?

A. Motion is a continued and successive change of place.

Q. What is the general tendency of bodies?

A. A body is indifferent as to motion or rest; but, when once put in motion, it would continue to move, were it not interrupted by some external cause.

Q. How many kinds of motion are there?

A. Motion, in astronomy, may be divided into simple and compound, real and apparent.

Q. What is simple motion?

A. Simple motion is that motion which is produced by one force acting upon and impelling a body.

Q. In what direction is simple motion?

A. A body impelled by one force, will move in a straight line.

Q. What is compound motion?

A. Compound motion is produced by two or more forces, acting upon a body.

Q. In what direction does the body move?

A. When a body is impelled by two forces, acting in different directions, it obeys neither, but moves in a line between them.

Q. What is real motion?

A. Real motion, in astronomy, is a successive change of place; as, the earth's annual and diurnal motions.

Q. What is apparent motion?

A. Apparent motion is an apparent change of place, when the body or object is actually at rest.

Q. Can you give an example of this motion?

A. Yes; in sailing along the shore of a lake, bay, &c., we observe that the trees, houses, and other objects seem to move in a contrary direction to that of the vessel; but this motion is only *apparent*, and produced by the real motion of the vessel.

APPARENT MOTIONS OF THE PLANETS, DIRECT, RETROGRADE, AND STATIONARY.

Q. What is meant by the direct motion of a planet?

A. The motion of a planet is said to be direct, when it is farthest from us; as d, *Plate* II. *Fig*. K.

Q. What is the retrograde motion of a planet?

A. The planets are said to move retrograde when nearest to us, at which time they seem to move backwards; as r, *Plate* II. *Fig*. K.

Q. When is a planet said to be stationary?

A. The planets, though actually in motion, are said to be stationary, when they are near to us, either in approaching or going from us, as s, *Plate* II. *Fig*. K.

Q. What is the cause of these appearances?
A. The planets appear direct, stationary and retrograde, because they do not move round the earth as a centre.

GRAVITATION.

Q. What is Gravitation?
A. Gravitation, in astronomy, is that principal or law by which the planets tend toward the Sun, and the Sun toward them.

CENTRIPETAL FORCE.

Q. What is Centripetal Force?
A. Centripetal, or attractive force, is that by which a moving body tends, or is drawn immediately toward a centre, and made to revolve in a curve.

CENTRIFUGAL FORCE.

Q. What is Centrifugal Force?
A. Centrifugal or projectile force, is that by which a body revolving about a centre, or about another body, endeavors to fly off from it.
Q. How are these forces regulated?
A. By the size and velocity of the body.

NOTE.—By the centripetal attraction of the Earth, E, the Moon, M, is retained in the curve M O. The satellites of Jupiter, Saturn, and the Georgium Sidus, all move in elliptical orbits, by this law. *See Plate* I. *Fig A.*

NOTE.—Thus the Moon, *m*, by centrifugal force endeavors to move in the line *m t*, but that force is counteracted by the centripetal attraction of the Earth E: the other satellites all endeavor to recede by the same law, but are made to move round their primaries by centripetal attraction. *See Plate* I. *Fig A.*

Q. If the centrifugal force of the Moon were destroyed, in what direction would it move?

A. The Moon would move directly to the Earth.

Q. How would the planets move?

A. If the centrifugal force of the planets were taken away, they would fall immediately toward the sun.

Q. What is the proportion?

A. Bodies attract one another with forces proportioned to the quantities of matter which they contain.

CHAPTER I.

Astronomy.

Q. WHAT is Astronomy?

A. Astronomy is the science which treats of the motions, magnitudes, periods, distances, &c. of the celestial bodies.

Q. From what is the word derived?

A. Astronomy is derived from two Greek words: *aster*, a star, and *nomos*, a law.

Q. How is astronomy divided?

NOTE.—Attraction decreases as the square of the distance; thus, if a body A be twice the distance from S that B is, the square of 2 being 4, the force of attraction at A will be four times less than at B, or the attraction at B will be twice as great as at A.

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A           B           S
O-----------O-----------O
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If A be three times the distance B, S, the square of 3 being 9, the attraction at A will be nine times less than at B; or by dividing 9 by 3, the attraction at B will be three times greater than at A.

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A                  B       S
O-------O----------O-------O
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A. Astronomy may be divided into *pure* and *physical.*

Q. What is *pure* astromomy ?

A. Plane, or pure astronomy, treats of the planetary motions, &c., without any allusion to the cause.

Q. What is *physical* astronomy ?

A. Physical astronomy contains the causes of the motions, periods, eclipses, &c. of the heavenly bodies, founded on the laws of gravitation.

Q. What is its use ?

A. On astronomy are founded Navigation and Dialling ; without the former, our geographical knowledge and commercial interests would by very limited.

CHAPTER II.

History of Astronomy.

Q. Is Astronomy of great antiquity ?

A. Astronomy was cultivated by the Chinese, Egyptians, Chaldeans, Greeks, and Indians, many centuries before the Christian era.

Q. Who were the most celebrated astronomers of antiquity ?

A. The astronomers of antiquity were Pythagoras, Ptolemy, and other Egyptians, Tycho Brahe, and Copernicus.

Q. What was the system of Pythagoras ?

A. In the Pythagorean system the sun was placed in the centre, round which the planets and comets were supposed to move from west to east in elliptical orbits.

Q. What planets were then discovered ?

A. The planets known in the time of Pythagoras, were Mercury, Venus, the Earth, Mars, Jupiter, and Saturn.

Q. About what time did Pythagoras flourish?

A. Pythagoras flourished about 590 years before the Christian era.

Q. In what order did Ptolemy consider the planets arranged?

A. Ptolemy supposed the Earth to be at rest in the centre, and round it moved the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn, in circular orbits, once every day.

Q. About what time did Ptolemy flourish?

A. Ptolemy, the Egyptian philosopher, flourished 130 years before the Christian era.

Q. What other systems did the Egyptians receive?

A. To account for the phases of Mercury and Venus, the Egyptians supposed the Earth to be immovable in the centre; then the Moon and the Sun, round which moved Mercury and Venus; and round the whole, Mars, Jupiter, and Saturn.

Q. What was the system of Copernicus?

A. Copernicus revived the doctrine of Pythagoras; and, with the discoveries of Herschel, Olbers, Piazzi, Harding, &c., and the proofs adduced in the Newtonian philosophy, this system is now universally received.

Q. Who was Copernicus?

A. Copernicus was a native of Poland, and flourished A.D. 1530.

Q. What was the system of Tycho Brahe?

A. In the Tychonic theory the Earth was supposed the centre of the Sun and Moon; Mercury, Venus, Mars, Jupiter, and Saturn, revolved about the Sun; while the Sun and planets moved round the Earth once in 24 hours.

Q. Who was Tycho Brahe?

A. Tycho Brahe was a Danish philosopher, and flourished A.D. 1586.

Q. What planets have since been discovered?

A. Since the death of Tycho Brahe, five primary planets have been discovered, viz. Herschel, Vesta, Juno, Ceres and Pallas.

THE SOLAR SYSTEM.

Q. Of what does the Solar system consist?

A. The solar system consists of the Sun and 11 planets, viz., Mercury, Venus, the Earth, Mars, Vesta, Juno, Ceres, Pallas, Jupiter, Saturn, and Herschel.

Q. How many secondary planets are there?

A. There are 18 satellites, or secondary planets, viz., the Moon, four satellites of Jupiter, seven of Saturn, and six of Herschel.

CHAPTER III.

The Sun.

Q. WHAT is the Sun?

A. The Sun is a body nearly globular, placed in the centre of the solar system, and is the source of light, heat and animation.

Q. What is his supposed substance, and how is light produced?

A. Dr. Herschel supposes the Sun to be a solid opaque body, surrounded by an extensive lucid, and

NOTE.—Vesto, Juno, Ceres, and Pallas, are by some called asteroids, or minor planets; Mercury and Venus are called inferior, being between the Sun and the Earth; and the rest superior.

transparent atmosphere, of a phosphoric nature, by which light is generated.

Q. What is the velocity of light?

A. It moves 200,000 miles in a second.

Q. How far is the Sun distant from the Earth?

A. The Sun is 95,000,000 of miles distant from the Earth.

Q. What is the length of the Sun's diameter?

A. The equatorial diameter of the Sun is 883,246 miles, and the polar a little less.

Q. What is his circumference?

A. The Sun's circumference is 3,774,692 miles.

Q. How many times is he larger than the Earth?

A. The Sun is 1,402,344 times greater than the Earth.

Q. How many motions has the Sun?

A. The Sun has two real and two apparent motions.

Q. What are the real motions?

A. The first motion of the Sun is a small circular motion round the centre of all the planets.

Q. What is the cause?

A. The motion is occasioned by the various attractions of the surrounding planets.

Q. What is the second real motion?

A. The Sun turns upon its axis once in 25 days 10 hours.

Note.—To find how many times one planet is greater than another:

Rule.—Cube the diameter of each planet and divide the greater number by the less, the quotient will give the proportional magnitudes, or the number of times one is greater than the other.

To find how many times the Sun is greater than the Earth: The Earth's diameter is 7,914 miles, and the Sun's diameter 885,824; the cube of 7,914 is 49,564,155,684, and the cube of 885,824 is 695,092,060,440,746,224; which divided by 49,564,155,684, gives the quotient 1,402,344, so that the Sun is 1,402,343 times greater than the Earth.

Q. What is the use of his diurnal motion?

A. It seems probable that the Sun's diurnal motion is to throw off centrifugal light though the zodiac, giving annual and diurnal motion to the planets.

Q. What are the apparent motions of the Sun?

A. The Sun's first apparent motion is the diurnal motion from east to west.

Q. What is the cause?

A. This motion arises from the real motion of the Earth upon its axis.

Q. What is the second?

A. The second is the Sun's apparent annual motion in the ecliptic.

Q. What is the cause?

A. The Sun's apparent annual motion arises from the Earth's motion in its orbit.

Q. Has the Sun any other motion?

A. Dr. Herschel is of opinion, that the Sun and the planets have a general motion with regard to the fixed stars.

Q. In what direction is this general motion?

A. This general motion of the sun and planets is supposed to be toward the constellation Hercules.

Q. What is the supposed height of the Sun's atmosphere?

A. Dr. Herschel is of opinion, that the Sun's atmosphere is not less than 1,843 miles in height.

Q. What are the solar spots?

A. The spots often observed on the Sun are supposed to be his dark body seen through rarified parts of his atmosphere.

Q. Was not the Sun formerly supposed to be a body of fire?

NOTE.—A spectator in the Sun would see the Earth apparently move from west to east, for the same reason that we see the Sun move from east to west.

A. The Sun was formerly supposed to be a body of fire; but experience has proved, not only the tops of the mountains, but the upper regions of the atmosphere, to be intensely cold.

Q. Is the Sun supposed to be inhabited?

A. From the similarity to the Earth and the other planets, with regard to atmosphere, diversity of surface, &c., there is every reason to believe that the Sun may be inhabited.

CHAPTER IV.

Eclipse of the Sun.

Q. WHAT is a solar eclipse?

A. A solar eclipse is a partial darkness, which is occasioned when the Moon comes between the Sun and the Earth, and is either *total* or *partial*. *See Plate* II. *Fig.* M.

Q. What is a total eclipse?

A. A total eclipse of the Sun, is when his whole face is obscured by the opaque body of the Moon.

Q. Do total eclipses often happen?

A. Total eclipses of the Sun are very rare, and can only happen when the Moon is nearest the Earth, or in one of the nodes.

Q. What is a partial eclipse?

A. A partial eclipse of the Sun takes place when only a part of his surface is darkened.

Q. What is meant by an annual eclipse?

A. An annual eclipse is a partial central eclipse, when the Earth is at a distance, and the Moon has a luminous ring round her body.

Q. What is the ring?

A. The luminous ring round the Moon, in a central partial eclipse, is the body of the Sun, not able to cover, so as to obscure the whole Moon's disc.

Q. Do solar eclipses happen often?

A. Solar eclipses happen much more frequently than those of the Moon, in the proportion of three solar to one lunar.

Q. How is it that they are not so often seen?

A. Solar eclipses are not visible at one place so frequently as lunar eclipses, because a lunar eclipse is visible to half the globe, whereas a solar eclipse is visible to only a small part.

Q. How is the size of an eclipse measured?

A. The whole diameter of the Sun is divided into 12 parts, called digits, and the Sun is eclipsed so many digits as the Moon covers.

Q. When do they happen?

A. An eclipse of the Sun can only happen at the change of the Moon, or when she is in conjunction.

Q. What is the greatest number of eclipses that can happen in a year?

A. Seven; and in that case five will be solar and two lunar.

Q. What is the least number that can happen in a year?

A. Two; and these must both be solar.

CHAPTER V.

Mercury.

Q. What is Mercury?

A. The planet Mercury is the nearest to the Sun, and has a bright blue appearance.

Q. What is the length of its diameter?

A. The diameter of Mercury is 3,130 English miles.
Q. What is its circumference?
A. The circumference of Mercury is 9,837 miles.
Q. How far is it distant from the Sun?
A. The distance of Mercury from the Sun is 36,774,320 miles.
Q. What is its size compared with the Earth?
A. The Earth is $16\frac{1}{6}$ times greater than Mercury.
Q. Does Mercury turn on its axis?
A. Mercury turns on its axis in 24 hours 5 minutes and 28 seconds.
Q. In what time does Mercury revolve round the Sun?
A. The annual revolution of Mercury round the Sun, is performed in 87 days 23 hours 15 minutes and 44 seconds of time.
Q. At what rate does it move per hour.
A. Mercury moves at the mean rate of 109,442 miles per hour.
Q. What is its eccentricity?
A. The eccentricity of Mercury is 7,424,424 miles.
Q. What is meant by the phases of Mercury?
A. Mercury has changes, like the Moon: it is some-

Note.—To find the distances of the planets from the Sun.
Rule.—As the square of the Earth's period of revolution round the Sun is to the cube of its distance, so is the square of any other planet's annual period of revolution to the cube of its distance; and the cube root of the number thus found, will be the planet's distance from the Sun.

To find the distance of Mercury from the Sun, its period being 88 days:

The square of 365 is 133,225.
The cube of 95 is 857,375.
The square of 88 is 7,744.

As 133,225 : 857,375 : : 7,444 : 49,836, and the cube root of 49,836 is 36 3-4 millions of miles.

In the same manner may be found the distance of the other planets from the Sun.

times horned, sometimes gibbous, but never quite full.

Q. Why does the face or disc of Mercury never appear full?

A. Mercury never appears full to us, because the full enlightened side is never turned towards us, excepting when it is lost in the Sun's beams.

Q. What do the phases demonstrate?

A. The phases of Mercury clearly prove, that the planet is dark or opaque of itself, without the light of the Sun.

Q. What is meant by the transit of Mercury?

A. When Mercury is between the earth and the Sun, it appears on the Sun's disc as a dark speck, which is called a transit.

Q. How would the Sun appear to a spectator in Mercury?

A. The Sun would appear to a spectator in Mercury seven times larger than it does to us.

CHAPTER VI.

Venus.

Q. What is Venus?

A. Venus is the most brillliant of all the planets, and may sometimes be seen at noonday.

Q. What is the length of its diameter?

A. The diameter of Venus is 8,600 miles.

Q. What is the circumference of Venus?

A. The circumference of Venus is about 27,000 miles, being somewhat larger than the Earth.

Q. How far is Venus distant from the Sun?

A. The distance of Venus from the Sun is 68,716,569 miles.

Q. In what time does it turn on its axis?

A. Venus turns round upon her axis in 23 hours 21 minntes and 7 seconds of time.

Q. In what time does it preform its orbit?

A. Venus moves round the Sun in 224 days 16 hours 49 minutes 11 seconds.

Q. At what rate does it move?

A. Venus moves at the rate of 80,062 miles per hour.

Q. What is her eccentricity?

A. The eccentricity of Venus is 492,000 miles

Q. Has Venus phases, like Mercury?

A. Venus, like Mercury, has phases similar to the Moon.

Q. What is a transit of Venus?

A. Transit of Venus is produced by the planet passing between the Earth and the Sun.

Q. Are the transits of Venus frequent?

A. The transits of Venus are rare, but of greater utility in Astronomy, than those of Mercury.

Q. What do the transits of Venus illustrate?

A. From a transit of Venus the Sun's true parallax has been ascertained.

Q. What is the use of the Sun's true parallax?

A. From the Sun's true parallax astronomers have been enabled to ascertain the Earth's distance from the Sun, as also the distances of the other planets.

Q. What else has been learned from observing the transits of Venus?

A. The atmosphere of Venus was observed to throw a shade on the Sun's disc about 5 seconds before the body of Venus touched his edge.

Q. What is its height?

A. The height of the atmosphere of Venus has been calculated to be 50 miles.

Q. When was this phenomenon first observed?

A. Venus was first observed to pass over the Sun's disc, Nov. 16, A. D. 1639.

Q. When will the next transit happen?

A. There will be only two transits of Venus in the present century; the first December 8th, 1874; and the second in 1882.

Q. What will the size of the Sun be to a spectator in Venus?

A. The Sun will appear twice as large to an inhabitant of Venus as to us; Mercury will be a morning and evening star to them, as Venus is to us.

Q. When is Venus called the morning star?

A. When it is in the upper part of its orbit, and rises before the Sun.

Q. When is Venus called the evening star?

A. When it passes round into the lower part of its orbit, and sets after the Sun.

Q. How long is Venus an evening, and how long a morning star?

A. Venus is 290 days an evening star, and a morning star somewhat longer.

Q. What else is worthy of notice in this planet?

A. Venus has exhibited bright and dark spots on her disc, and the mountains are six times higher than any on our globe.

Q. Where is her orbit?

A. Venus moves immediately within the orbit of the Earth.

CHAPTER VII.

The Earth.

Q. What is the Earth?

A. The Earth is the third planet from the Sun; and its orbit is next above that of Venus.

Q. Of what does it consist?

A. The Earth is a solid body of terrestial matter, nearly globular.

Q. What is the length of its diameter?

A. The equatorial diameter of the Earth is 7,924 miles, and the polar about 37 miles shorter.

Q. What is the circumference?

A. The Earth's circumference round the equator is 24,904 miles, and through the poles 24,773 miles.

Q. Does this flatness at the poles make any difference in bodies moved from either of them to the equator?

A. The weight of bodies is increased when taken from the equator toward the poles; if a body of the weight of one pound at the equator, was taken to either pole, it would weigh 1,00569 pounds.

Q. What is the cause of this change in gravity?

A. The equator being farther from the Earth's centre than either of the poles, the centripetal force is greatest at the equator.

Q. Has this difference any effect on the vibration of pendulums?

A. Pendulums of the same length vibrate lower at the equator than at the poles.

Q. How is this remedied?

A. By making the pendulum longer or shorter; thus, one to vibrate seconds at the equator, must be 39 inches long, and at the poles 39,209 inches.

Q. How far is the Earth from the Sun?

A. The distance of the Earth from the Sun is 95,000,000 miles.

Q. In what time does the light come from the Sun to the Earth?

A. The light of the Sun occupies 8 minutes 7½ seconds in coming to the Earth.

Q. How many motions has the Earth?

A. Two: the *diurnal*, and the *annual*, or the *daily* and the *yearly*.

Q. What is meant by the Earth's annual motion?
A. The Earth's annual motion is her revolution round the Sun.

Q. What does this produce?
A. The Earth's annual motion produces the changes of the season, viz.: *Spring*, *Summer*, *Autumn*, and *Winter*.

Q. In what time does the Earth preform a revolution round the Sun?
A. The Earth performs an annual revolution in 365 days and 6 hours.

Q. At what rate does she move in her orbit?
A. The Earth moves round the Sun at the rate of 60,000 miles per hour.

Q. What is the eccentricity of the Earth's orbit?
A. The Earth's eccentricity is 1,618,000 miles.

Q. In what time does the Earth turn on her axis?
A. The Earth turns upon her axis once in every 24 hours.

Q. What changes does this produce?
A. The Earth's rotation on her axis produces the change of day and night.

CHAPTER VIII.

The Moon.

Q. What is the Moon?
A. The Moon is an opaque body, nearly globular, and receives her light from the Sun.

Q. What is the use of the Moon?
A. The Moon is a satellite to the Earth, and partially supplies us with light in the absence of the Sun.

Q. Of what size is the Moon?

A. The Moon is about one fifteenth part of the size of the Earth; her diameter being 2,180 miles, and her circumference 6,851 miles.

Q. How far is she from the Earth?

A. The Moon moves at the distance of 240,000 miles from the Earth.

Q. How far is the Moon distant from the Sun?

A. The Moon's mean distance from the Sun in miles is 95,000,000.

Q. In what time does the Moon turn on her axis?

A. The Moon performs a rotation on her axis in 27 days 7 hours 43 minutes and 8 seconds.

Q. In what time does the moon preform her orbit?

A. The Moon performs her orbit exactly in the same time that she goes round the Earth.

Q. At what rate does she move?

A. The Moon moves in her orbit at the rate of 2,290 miles per hour.

Q. What is the length of her day and night?

A. The lunar day and night, taken together, are the same as our lunar month, viz.: 27 days 7 hours 43 minutes and 8 seconds.

Q. On what physical cause does the Moon's motion depend?

A. The Moon's motion is produced by the mutual attraction between the Earth and the Moon.

Q. What is meant by the Moon's phases?

A. The phases of the Moon are those changes which we observe in her shape; she is sometimes full, sometimes horned, and at other times gibbous, according as her dark side is turned toward us.

Q. When is it new Moon?

A. When the Moon is in conjunction, or between the Earth and the Sun, and the dark side is presented to us.

Q. When is it full Moon ?

A. When the Moon is in opposition, or when the Earth is between the Sun and the Moon, and the illuminated side is presented to us.

CHAPTER IX.

Eclipses of the Moon.

Q. What is meant by an Eclipse ?

A. An eclipse of the Moon is the privation of the Sun's light, occasioned by the dark body of the Earth coming between the Sun and Moon.

Q. When do they happen ?

A. Eclipses of the Moon can never happen but when the Moon is full.

Q. Why can they not happen ?

A. Eclipses of the Moon can only happen at full moon, because the Sun and Moon are only then in opposition.

Q. Why do eclipses not happen every opposition and conjunction.

A. The Moon is not always eclipsed when full, because her orbit does not coincide with the plane of the ecliptic at every opposition and conjunction.

Q. What is a partial eclipse ?

A. A partial eclipse is when only a part of the Moon's face falls within the dark shadow of the Earth.

Q. What is a total eclipse ?

A. A total eclipse happens when the shadow of the Earth covers the whole disc of the Moon.

Q. In what direction does an eclipse commence ?

A. The dark shadow of the Earth begins at the eastern side of the Moon, and leaves her on the west.

Q. On what does the obscuration depend?

A. The obscuration is either *partial* or *total*, according to the Moon's distance from the earth.

Q. How long do eclipses last?

A. The conical shadow of the Earth is sometimes more than three hours in passing over the Moon's disc.

Q. What is remarkable in the Harvest Moon?

A. The Moon when full in harvest rises several successive nights sooner after sunset, and with less difference of time, than at any other full Moon during the year.

Q. What is the cause?

A. The Moon rises for several nights nearly alike early, because she is full in the signs Pisces and Aries, while the Sun is in the opposite signs Virgo and Libra.

Q. How does this occasion a difference?

A. When the Sun is in Virgo and Libra, the opposite part of the ecliptic rises from the horizon in our latitude with a smaller angle.

Q. Why does this make so material a difference?

A. Pisces and Aries rising with a smaller angle, make the Moon move through a smaller space in a shorter time than she would through a large space.

Q. Why is not this always the case at full Moon?

A. The Moon would rise with less difference of time, as in Autumn, if the Moon's orbit lay in the the plane of the ecliptic.

Q. Why is not this the same in Winter, when the Moon is in Pisces and Aries?

A. The equality of the Moon's rising in winter is not observable, because she is then in her first quarter and rises about noon when the Sun is above the horizon.

Q. Why does it not happen in Spring?
A. In Spring the Moon is in those signs at her change when rising with the Sun she gives no light.
Q. Why does not this happen in Summer?
A. In Summer the Moon is in Pises and Aries, in her last quarter, and rising at midnight, is not noticed.
Q. Are these appearances always alike in the harvest Moons?
A. The harvest Moons are not every year alike, but they go through a periodical change every 19 years; sometimes more, and at other times less beneficial to the harvest, which may be more easily illustrated on a celestial globe.

CHAPTER X

Mars.

Q. Where is Mars situated?
A. Mars is situated next without the orbits of the Earth and Moon.
Q. What is the appearance of Mars?
A. Mars is of a dusky red color, owing to the density of its atmosphere.
Q. What is its diameter?
A. The equatorial diameter of Mars is 4200 miles, and its polar diameter 3931 miles.
Q. What is its circumference?
A. The circumference of Mars is 13,200 miles.
Q. In what time does it preform its orbit?
A. Mars moves round the Sun in 686 days 23 hours 30 minutes and 39 seconds.
Q. At what rate does it move?

A. Mars moves round the Sun at the rate of 55,166 miles per hour.

Q. In what time does it turn on its axis?

A. Mars turns once round its axis in 24 hours 39 minutes and 21 seconds.

Q. How far is Mars distant from the Sun?

A. Mars is distant from the Sun 244,760,806 miles.

Q. What is its eccentricity?

A. The eccentricity is Mars is 13,463,000 miles.

Q. Has Mars any atmosphere?

A. Dr. Herschel is of opinion, that the atmosphere of Mars is very considerable.

Q. Has Mars any phases?

A. Mars increases and decreases like the Moon, but never appears horned.

Q. What may be deduced from this?

A. The appearance of Mars clearly demonstrates, that it shines by means of solar light.

Q. How would the Earth appear to an inhabitant of Mars?

A. The Earth would appear to a spectator in Mars, like a star, or as Venus does to us.

Q. Has Mars any satellites?

A. Mars has no satellites as yet observed.

CHAPTER XI.

Vesta.

Q. WHAT is Vesta?

A. Vesta is one of the four minor planets, or asteroids.

Q. What is the appearance of Vesta?

A. Vesta shines with a purer light than any of the minor planets.

Q. Is this planet ever visible without glasses?

A. Vesta is often seen in a clear evening, without the aid of the telescope: her appearance is similar to that of the Georgium Sidus, or of a star of the fifth magnitude.

Q. Where does Vesta move?

A. The orbit of Vesta is between that of Mars and Ceres.

Q. How far is Vesta distant from the Sun?

A. Vesta is distant from the Sun 225,435,000 miles.

Q. In what time does it perform a revolution?

A. Vesta performs a revolution round the Sun in 1,335 days 4 hours 55 minutes and 12 seconds.

Q. At what rate does it move?

A. Vesta moves 44,202 miles every hour.

Q. What is the eccentricity of this planet?

A. The eccentricity of Venus is 21,015,053 miles.

Q. When was Vesta discovered?

A. Vesta was discovered early in the year 1807.

Q. By whom was Vesta discovered?

A. Vesta was discovered by Dr. Olbers, a physician, of Brunn, in Germany.

Q. When was she first observed in England?

A. In England, Vesta was first observed at Blackheath, by Mr. Groombridge, April 26, 1807.

Q. Is there any thing remarkable in the orbit of Vesta?

A. The orbit of Vesta cuts the orbit of Pallas, but not where it is cut by Ceres.

CHAPTER XII.

Juno.

Q. Where is Juno situated?

A. Juno, one of the minor planets, moves between the orbits of Vesta and Pallas.

Q. What is its size?

A. The diameter of Juno is about 1,400 miles.

Q. What is its appearance?

A. Juno is of a reddish color, but free from that nebulosity which surrounds Pallas.

Q. Has Juno any atmosphere?

A. Schroeter is of opinion, that the atmosphere of of Juno is more dense than any of the planets; but it is sometimes very brilliant.

Q. To what may the changes be attributed?

A. The planet Juno appears sometimes very brilliant, owing to certain changes in the density of its atmosphere.

Q. How far is Juno from the Sun?

A. The distance of Juno from the Sun is 253,380,485 miles.

Q. In what time does it perform its orbit?

A. Juno moves round the Sun in 1,590 days 23 hours and 57 minutes.

Q. At what rate does it move?

A. Juno moves at the rate of 41,170 miles every hour.

Q. What is its eccentricity?

A. The eccentricity of Juno is 68,588,343 miles.

Q. When and by whom was Juno discovered?

A. On the 1st of September, 1804, Juno was first discovered by Mr. Harding, of Lilienthal, in the neighborhood of Bremen.

CHAPTER XIII.

Ceres.

Q. WHAT is the appearance of Ceres?

A. The planet Ceres appears like a star of the sixth magnitude, and has a ruddy appearance.

Q. What is the cause of this ruddy appearance?

A. Ceres exhibits a ruddy appearance, because it is surrounded by a dense atmosphere subject to numerous changes.

Q. What is the supposed height of the atmosphere?

A. The atmosphere of Ceres, according to Schroeter, is 676 miles in height; and, like that of the Earth, it becomes gradually thinner toward the top.

Q. When and by whom was Ceres discovered?

A. The planet Ceres was first seen January 1st, 1801, by M. Piazzi, of Palermo.

Q. What is the diameter of Ceres?

A. Schroeter makes the diameter of Ceres to be 1624 miles, while Dr. Herschel reckons it only 160 miles.

Q. How is this difference accounted for?

A. The German astronomer Schroeter maintains that the micrometer used by Herschel was placed too far from the eye, and that only the clear part of the nucleus of the planet had been measured.

Q. What is the distance of Ceres from the Sun?

A. The distance of Ceres from the Sun is 262,903,570 miles.

Q. In what time does Ceres move round the Sun?

A. Ceres moves round the Sun in 1681 days 2 hours and 56 minutes.

Q. At what rate does Ceres move?

A. Ceres moves round the Sun at the rate of 40,930 miles per hour.

Q. What is the eccentricity of this planet?
A. The distance of the centre from the foci of the elliptical orbit of Ceres, is 20,598,130 miles.
Q. Where does Ceres move?
A. The orbit of Ceres is without that of Juno.

CHAPTER XIV.

Pallas.

Q. When and by whom was Pallas discovered?
A. The planet Pallas was discovered March 28th, 1802, by Dr. Olbers, at Bremen, in Lower Saxony.
Q. What is the appearance of Pallas?
A. Pallas is less ruddy than Ceres, owing to the smaller extent of atmosphere and nebulosity.
Q. What is the height of the atmosphere?
A. The atmosphere of Pallas is 468 miles in height, and undergoes similar changes to Ceres; but her light is exhibited in great variations.
Q. What is the size of this planet?
A. Pallas, according to Schroeter, is 2099 miles in diameter, but, according to Herschel, 80 miles.
Q. What is the distance from the Sun?
A. The distance of Pallas from the Sun is 266,000,000 miles.
Q. In what time does Pallas perform a revolution?
A. Pallas revolves round the Sun in 1681 days 17 hours and 1 minute.
Q. At what rate does Pallas move?
A. Pallas moves round the Sun at the rate of 40,930 miles per hour.
Q. What is the eccentricity of this planet?
A. The eccentricity of Pallas is 64,516,673 miles.

Q. Is there any thing remarkable in this planet?
A. The orbit of Pallas crosses that of Ceres.
Q. How does this happen?
A. Ceres crosses the orbit of Pallas, owing to the great eccentricity of the latter.

CHAPTER XV.

Origin of Ceres, Pallas, Juno, and Vesta.

Q. What is the supposed origin of the four minor planets?
A. Some have supposed them to have been originally one planet.
Q. What leads to this conjecture?
A. The great space between the orbits of Mars and Jupiter does not, without another planet, seem to agree with the harmony of proportionable distance in the solar system.
Q. How is this accounted for?
A. The four minor planets are supposed to have been separated from one original planet, by some convulsion in nature, capable of destroying the mutual attraction of the fragments; such as an earthquake.
Q. How are we to expect to find these fragments, according to this theory?
A. It is evident, that the smaller parts would, by the explosive force, be thrown to the greatest distance from the original orbit, while the greater fragments, on account of their gravity, would deviate less from the original path of the primitive body.
Q. Is this the case with the new planets?
A. Pallas and Juno are, on account of their eccentricity, supposed to be smaller then Ceres and Vesta.

Q. Does this theory explain any other phenomena in nature?

A. This theory has furnished us with evidence, that the meteoric stones commonly called thunderbolts, may be the smaller fragments of an original planet.

Q. How is that possible?

A. The cohesive force of the planet being destroyed by the explosive force, a number of smallar fragments would be precipitated with great velocity, without the sphere of the planet's attraction.

Q. Would not these smaller fragments be attracted by Mars, and fall toward that planet rather than toward the Earth?

A. The meteoric stones might be precipitated within the sphere of the Earth's attraction, when Mars was at a remote part of its orbit.

Q. When within the sphere of the Earth's attraction, how would they move?

A. The fragments thus precipitated within the sphere of the Earth's attraction, might revolve round it at different distances.

Q. What would occasion their fall?

A. The meteoric stones might fall from a diminution of their centrifugal force, or by being struck with electric fluid.

Q. What is their particular substance?

A. The meteoric stones are principally composed of iron; those found in South America and Siberia are masses of melted iron, and possessed of magnetic virtue.

Q. From what part of the planet are they supposed to be precipitated?

A. From the internal density and magnetism of the Earth, we are led to conclude, that the central part, and greater part of the Earth is either iron, stone, or melted metals, which have the power of magnetism, and the meteoric stones are found to be iron ore.

Q. How is this applicable to meteoric stones?

A. When an internal explosion takes place in a planet, the central parts of the planet's substance must be thrown to the greatest distance; and, from their similarity to our Earth, we have every reason to suppose the meteoric stones to have been precipitated from the planet's centre.

CHAPTER XVI.

Jupiter.

Q. WHERE is Jupiter situated?

A. Jupiter's orbit is between those of Pallas and Saturn.

Q. What is its size?

A. Jupiter, the largest of all the planets, is more than a thousand times larger than the Earth.

Q. What is its diameter?

A. The eqatorial diameter of Jupiter is 91,000 miles, and its polar diameter 6000 miles shorter.

Q. What is its distance from the Sun?

A. Jupiter is distant from the Sun 492,265,155 miles.

Q. In what time does it perform its orbit?

A. Jupiter moves round the Sun in 4332 days 14 hours and 19 seconds.

Q. At what rate does it move?

A. Jupiter in his orbit round the Sun moves at the mean rate of 298,660 miles per hour.

Q. In what time does it turn on its axis?

A. Jupiter turns round on its axis in 9 hours 55 minutes and 50 seconds.

Q. At what rate does it move?

A. The equatorial parts of Jupiter, in revolving on its axis, is about 26,000 miles per hour.

Q. Is there any difference of season in Jupiter?

A. Jupiter's axis being perpendicular, or having no inclination, it can have no difference of seasons.

Q. What is the length of its day?

A. The length of the day in Jupiter is five hours and its night the same.

Q. What is the state of the polar regions?

A. In the polar regions of Jupiter there is perpetual winter.

Q. What is the state of the parts near the equator?

A. About the equator of Jupiter is perpetual summer.

Q. What are the belts of Jupiter?

A. The belts, or zones, are faint substances seen on the body of Jupiter, and supposed to be clouds floating in its atmosphere.

Q. How many belts are there?

A. The belts of Jupiter are always parallel to its equator; the number is variable; sometimes eight may be seen, at other times only one.

Q. What are the spots seen in those belts?

A. The dark spots seen on the surface of Jupiter, are supposed to be clouds more dense than the ring; and, when the belts disappear, the spots vanish also.

Q. About what time do they generally continue?

A. The spots on the belts of Jupiter, sometimes continue the same for three months: at other times new ones spring up during observation.

Q. Are they all supposed to be clouds floating in its atmosphere?

A. There is one large spot which has been observed to continue for three years together, and is supposed to be a part of the body of Jupiter, seen through a rarified part of its atmosphere.

Q. What are the uses of these spots ?
A. By observing these spots, the time of Jupiter's rotation on its axis has been found.

CHAPTER XVII.

Jupiter's Satellites.

Q. How many Satellites has Jupiter ?
A. Jupiter has four satellites or moons, which move round its body from west to east, at different periods and distances. See *Plate* I. *Fig.* c.
Q. When and by whom were they discovered ?
A. In 1610, the satellites of Jupiter were discovered by Galileo.
Q. At what distance is the first ?
A. The first satellite is distant from the centre of Jupiter, 264,490 miles.
Q. What time does it require to move around its primary ?
A. The first satellite moves round the body of Jupiter in 1 day 18 hours 27 minutes and 23 seconds.
Q. What is the distance of the second ?
A. The second satellite is distant from Jupiter 420,815 miles.
Q. In what time does it perform a revolution ?
A. The second satellite of Jupiter performs a revolution in 3 days 13 hours 13 minutes and 42 seconds.
Q. What is the distance of the third satellite ?
A. The third satellite of Jupiter moves at the distance of 671,234 miles.
Q. What is its period.
A. Jupiter's third satellite performs its orbit in 7 days 3 hours 42 minutes and 33 seconds.

Q. What is the distance of the fourth satellite?

A. The fourth satellite of Jupiter is distant from the centre of that planet 1,180,582 miles.

Q. In what time does it perform its orbit?

A. The fourth satellite of Jupiter performs a revolution in 16 days 16 hours 31 minutes and 50 seconds.

Q. What is the use of the satellites to the inhabitants of Jupiter?

A. The satellites or moons of Jupiter, serve to enlighten that planet, the same as the Moon does the Earth.

Q. Of what use are they to us?

A. By observing the immersion and emersion of Jupiter's satellites, they are of the greatest use in finding the longitude of places.

Q. Why are they of use?

A. Because the immersion and emersion takes place at the same instant of time on every part of the Earth's surface.

Q. Which satellite is best for the purpose?

A. The motion of the first being best known, and its eclipses happening more frequently than those of the other planets, its eclipses are the best for ascertaining the longitude of places.

Q. How is the longitude found?

A. The longitude of any place may be found, by taking the difference of the immersion and emersion observed from the corresponding time in the Ephemeris; this time turned into degrees will show the distance east or west from Greenwich.

Q. How is time turned into degrees of distance?

A. Time is turned into degrees of distance, by allowing 15 degrees to every hour of time.

CHAPTER XVIII.

Saturn.

Q. What is the appearance of Saturn?
A. Saturn shines with a pale dead light, on account of its vast distance from the Sun.
Q. What is its size?
A. The equatorial diameter of Saturn is about 79,000 miles, and its polar diameter about 71,000 miles.
Q. What is its circumference?
A. The circumference of Saturn is 244,137$\frac{1}{7}$ miles.
Q. How far is it distant from the Sun?
A. Saturn's distance from the Sun is 906,183,000 miles.
Q. In what time does Saturn perform its orbit?
A. Saturn moves round the Sun in 10,758 days 23 hours and 17 minutes, or about 30 years.
Q. At what rate does it move?
A. Saturn moves at the rate of 22,050 miles per hour.
Q. In what time does it turn on its axis?
A. Saturn performs a rotation on its axis in 10 days 16 hours and 19 minutes.
Q. What is its eccentricity?
A. The eccentricity of Saturn's obrit is 49,000,000 miles.
Q. Of what nature are the belts or zones seen on its disc?
A. The zones or belts of Saturn are similar to those of Jupiter, and originate from the same cause.
Q. What is the supposed cause?
A. The zones of Saturn are considered to be clouds floating in its atmosphere.

Q. What kind of atmosphere has it?

A. The atmosphere of Saturn is observed to be very dense.

Q. What else is remarkable in Saturn?

A. Saturn is surrounded by two concentric rings.

Q. What are these supposed to be?

A. Some have supposed the substance of the rings to be a vast assemblage of planets; others have supposed them to be a permanent bright cloud. Dr. Herschel has observed that they cast a shadow upon the planet.

Q. What is the use of these rings?

A. The rings are supposed to reflect the light of the Sun upon the planet Saturn.

Q. What is the distance of the first from Saturn?

A. The first, or inner ring, is distant from Saturn 21,000 miles.

Q. What is the breadth of the inner ring?

A. The breadth of Saturn's inner ring is 20,000 miles.

Q. What is the distance between the two rings?

A. The outer ring of Saturn is distant from the inner ring 2839 miles.

Q. What is the breadth of the outer ring?

A. The outer ring of Saturn is 7200 miles broad.

Q. Are these rings stationary?

A. The rings of Saturn revolve round its body in 10 hours and 33 minutes.

NOTE.—As this planet revolves around the Sun, one of its sides is illuminated during one-half of the year, and the other side during the other half; so that, as one of Saturn's years is equal to 30 of our years, one-half of his sides will be enlightened and darkened, alternately every 15 years.

CHAPTER XIX.

Satellites of Saturn.

Q. How many satellites has Saturn?

A. Saturn has seven satellites, moving at different distances from its body.

Q. What is the distance of the first satellite?

A. The first satellite is distant from Saturn 119,627 miles.

Q. In what time does it perform a revolution?

A. It moves round the planet Saturn in 23 hours 37 minutes and 23 seconds.

Q. How far is the second distant?

A. The second satellite is distant from Saturn 153,496 miles.

Q. What is the time of performing its orbit?

A. The second satellite performs its orbit in 1 day 8 hours 53 minutes and 9 seconds.

Q. How far is the third distant?

A. The third satellite from Saturn moves at the distance of 190,044 miles.

Q. In what time does it perform a revolution?

A. Saturn's third satellite performs a revolution in 1 day 21 hours 18 minutes and 26 seconds.

Q. What is the period and distance of the fourth?

A. The fourth satellite of Saturn moves round it in 2 days 17 hours 44 minutes and 51 seconds, at the mean distance of 243,449 miles.

Q. What is the period and distance of the fifth satellite?

A. The fifth satellite of Saturn performs its orbit in 4 days 12 hours 25 minutes and 11 seconds, at the distance of 340,005 miles.

Q. What is the period and distance of the sixth?

A. The sixth satellite of Saturn performs its orbit in 18 days 22 hours 41 minutes and 14 seconds, at the mean distance of 788,258 miles.

Q. What is the period and distance of the seventh?

A. The seventh and most remote satellite of Saturn performs a revolution in 79 days 7 hours 54 minutes and 37 seconds, at the distance of 2,297,541 miles.

Q. Is there any thing to remark on the last satellite?

A. The most remote of Saturn's satellites performs a rotation on its axis, like our Moon.

Q. In what time does it perform a revolution on its axis?

A. The seventh satellite of Saturn turns on its axis in the same time that it performs its revolution round Saturn, viz.: in 107 days 16 hours 39 minutes and 56 seconds.

CHAPTER XX.

Herschel, or the Georgium Sidus.

Q. When and by whom was Herschel discovered?

A. Herschel was discovered at Bath, March 13th, 1781, by Dr. Herschel; he afterwards discovered its six satellites.

Q. Was Herschel never observed till 1781?

A. Herschel was observed by Flamstead, Mayer, and Le Mounier; but they considered it to be a small star.

Q. Why was it called the Georgium Sidus?

A. This name was given to it as a testimony of respect to George the Third, of England, in whose reign it was discovered; though it is now generally called *Herschel*, in honor of its first discoverer.

Q. Where is this planet situated?

A. Herschel is the most remote planet in the solar system.

Q. What is its appearance?

A. It shines with a bluish white light, and is seldom seen without the aid of a powerful telescope.

Q. What is its distance from the Sun?

A. The distance of Herschel from the Sun is 822,418,976 miles.

Q. What is its eccentricity?

A. The eccentricity of Herschel is 1,800,000,000 miles.

Q. What is its diameter?

A The diameter of Herschel is 34,170 miles.

Q. What is the period of its revolution?

A. The period of this planet is 30,646 miles per hour.

Q. At what rate does it move?

A. It moves in its revolution round the Sun, at the rate of 15,546 miles per hour.

Q. In what time does it turn on its axis?

A. The rotation of Herschel on its axis has not as yet been determined, owing to its immense distance from the Earth.

CHAPTER XXI.

Satellites of Herschel.

Q. How many satellites has Herschel?

A. It has six satellites.

Q. Were the satellites discovered the same time as the planet?

A. The satellites have been discovered since the planet by Dr. Herschel.

Q. What is the period and distance of the first satellite of Herschel?

A. The first satellite of Herschel performs a revolution in 5 days 21 hours 25 minutes and 21 seconds, at the distance of 204,155 miles.

Q. What is the period and distance of the second?

A. The period of the second is 8 days 16 hours 57 minutes and 47 seconds, at the distance of 290,821 miles.

Q. What is the period and distance of the third?

A. The third satellite of Herschel performs its orbit in 10 days 23 hours 3 minutes and 59 seconds, at the distance of 339,052 miles.

Q. What is the period and distance of the fourth?

A. The fourth satellite of Herschel performs its orbit in 13 days 10 hours and 56½ minutes, at the distance of 388,718 miles.

Q. What is the period and distance of the fifth?

A. The fifth satellite moves round Herschel in 38 days 1 hour and 48 minutes, at the distance of 777,487 miles.

Q. What is the period and distance of the sixth satellite?

A. The sixth satellite of Herschel performs its orbit in 107 days 16 hours 39 minutes and 56 seconds, at the distance of 1,555,872 miles.

Q. Is there at any thing remarkable in the motion of these satellites?

A. The satellites of Herschel are supposed to move retrograde, or contrary to the order of the signs.

CHAPTER XXII.

Comets.

Q. What are the Comets?

A. The Comets are solid and opaque planetary bodies, moving in elliptical orbits, of great eccentricity.

Q. From what is the word derived?

A. Comet is derived from *cometa,* hairy; because they generally appear with tails resembling hair thrown in an opposite direction to the Sun.

Q. What is this tail supposed to be?

A. The tails of Comets are supposed to be vapors arising from the body of the comets by the heat of the Sun.

Q. What is the head or body called?

A. The head or solid part of a comet is called the *nucleus.*

Q. Have the comets any atmospheres?

A. The comets are, to appearances, surrounded by atmospheres ten times higher than the *nucleus.*

Q. Have they any phases?

A. Some of the comets have phases like the Moon, and recede far beyond the orbits of any known planet at their aphelion.

Q. In what direction do they move?

A. Some of the comets move direct in the order of the zodiacal signs; others move retrograde.

Q. Is their motion regular?

A. The motion of the comets is accelerated when moving towards, and retarded in going from the Sun.

Q. At what rate do the comets move?

A. The comet of 1680, at its perihelion was supposed to move at the rate of 880,000 miles per hour.

Q. How near did that comet approach the Sun?

A. The comet of 1680 approached within 130,000 miles to the surface of the Sun.

Q. Are the comets numerous?

A. About 500 comets have, at different periods, been observed; but the elements of ninety only have been computed.

Q. How near did they approach to the Sun?

A. Of the 90 comets, 22 passed between Mercury and the Sun, 40 between Venus and Mercury, 17 between the Earth and Venus, 16 between the Earth and Mars, and 4 between Mars and Jupiter.

Q. What is the supposed size of comets?

A. They are of different magnitudes; the greater number are supposed to be less than the Moon.

Q. What is the supposed length of their tails?

A. The tails of comets in length are various; that of 1811 was computed to be 33,000,000 miles long.

CHAPTER XXIII.

Fixed Stars.

Q. WHAT are the fixed stars?

A. The fixed stars are those bodies which appear in the immensity of space far beyond the planetary system.

Q. How far are they distant?

A. The nearest fixed star is supposed to be distant from the Earth 2,940,000,000 miles.

Q. What is to be observed of their light and motion?

A. The fixed stars are supposed to be stationary bodies, and shining by their own light.

Q. How are they classed?

A. They have been classed into six magnitudes, namely; the largest are called stars of the first magnitude; the next stars, of the second; and so on to the sixth, which are the least.

Q. How is a star distinguished from a planet?

A. The fixed stars twinkle, or have an unsteady light; whereas, the planets shine with a steady light.

Q. Is there any other distinction?

A. The fixed stars keep the same relative distance from each other; while the planets are seen in various parts of the heaven.

Q. Is there any other method of distinguishing the planets from the fixed stars?

A. The planets are sometimes seen with the naked eye during the day, and are always visible before the fixed stars in the evening.

Q. What are telescopic stars?

A. The telescopic stars are such as cannot be seen without the aid of the telescope.

Q. What are the uninformed stars?

A. The uninformed stars are such as are not arranged under any particular constellation.

Q. How many stars are supposed to be visible at any one time?

A. Not more than 1000 stars are above the horizon, visible to the naked eye at one time.

Q. What are periodical stars?

A. Periodical stars are such as appear and disappear: thus, some stars known to the ancients, are now invisible; and many which are visible, were not noticed by the ancients.

Q. What is the supposed cause?

A. A periodical star is supposed to turn slowly on its axis, and to have one dark side, and when that is turned toward us, the star is invisible.

Q. How is the situation of the fixed stars known?

A. To know the situation of the stars, they are divided into constellations.

CHAPTER XXIV.

Constellations.

Q. What is a Constellation?

A. A Constellation is an imaginary figure formed by a group of contiguous stars.

Q. How many stars are there in the nothern hemisphere?

A. There are 1251 stars in the nothern hemisphere.

Q. How many of each magnitude?

A. In the northern hemisphere there are 6 stars of the first magnitude, 24 of the second, 96 of the third, 200 of the fourth, 291 of the fifth, and 635 of the sixth magnitude.

Q. How many stars are there in the zodiac?

A. There are in the zodiac 1014 stars.

Q. How many of each magnitude?

A. In the zodiac are 5 stars of the first magnitude, 16 of the second, 44 of the third, 120 of the fourth, 183 of the fifth, and 646 of the sixth magnitude.

Q. How many stars are there in the southern hemisphere?

A. In the southern hemisphere there are 863 stars.

Q. How many of each magnitude?

A. There are in the southern hemisphere, 9 stars of the first magnitude, 36 of the second, 84 of the third, 190 of the fourth, 221 of the fifth, and 324 of the sixth magnitude.

Q. In the northern hemisphere, zodiac, and southern hemisphere, how many stars are there of each magnitude?

A. In both hemispheres and zodiac there are 20 stars of the first magnitude, 76 of the second, 223 of the third, 510 of the fourth, 695 of the fifth, and 1604 of the sixth magnitude.

Q. How many constellations are there?

A. There 91 constellations, viz.: 34 in the northern hemisphere, 12 in the zodiac, and 45 in the southern hemisphere.

CHAPTER XXV.

Constellations north of the Zodiac.

DIVIDED INTO LESSONS.

Lesson I.

	Names of Constellations.		STARS.	*No. of Remarkable Stars.*	MAGNITUDES.
1	Ursa Minor	The Little Bear	24	Pole Star	2
2	Ursa Major	The Great Bear	87	Dubbe	1
3	Perseus	Perseus	59	Algenib	2
	Caput Medusæ	Medusa's Head		Algol	2
4	Auriga	The Wagoner	56	Capella	1
5	Bootes		54	Arcturus	1

Lesson II.

6	Draco	The Dragon	60	Rastaben	3
7	Cepheus		35	Aldermin	3
8	Canes Venatici, or Asterion and Chara.	The Hounds	25		
9	Cor Caroli	Charles' Heart	3		
10	Triangulum	The Triangle	11		

Lesson III.

11	Triangulum minus	The Little Triangle	5		

12	Musca	The Bee or Fly	6	
13	Lynx		44	
14	Leo minor	The Little Lion	24	
15	Coma Berenices	Berenice's Hair	40	
16	Cameleopardalus	The Cameleopard	58	

Lesson IV.

17	Mons Mænalus	Mount Mænalus	11	
18	Corona Borealis	The Northern Crown	21	
19	Serpens	The Serpent	50	
20	Scutum Sobieski	Sobieski's Shield	8	
21	Hercules cum Ramo et Cerbero	Hercules with the Branch and Cerberus	113	Ras Algiatha...3

Lesson V.

22	Serpentarius sive Ophiucus.	The Serpent Holder	67	Ras Alhagus....3
23	Taurus Poniatowski	Poniatowski's Bull.	7	
24	Lyra	The Harp	22	Vega.............1
25	Vulpecula et Anser	The Fox and Goose	37	
26	Sagitta	The Arrow	18	

Lesson VI.

27	Aquila et Antinous	The Eagle	40	
28	Delphinus	The Dolphin	18	
29	Cygnus	The Swan	73	Deneb Adigel...1
30	Equulus	The Colt	10	

31 Lacerta............	The Lizard..........16		
32 Pegasus............	The Flying Horse..85	Markab. 2	
33 Andromeda........	66	Almaac..........2	
34 Cassiopeia.......	The Lady in the Chair...............55	Schedar..........3	

CHAPTER XXVI.

Constellations in the Zodiac.

NORTHERN CONSTELLATIONS.

Lesson VII.

In Spring.

1 Aries................	The Ram............66	
2 Taurus..............	The Bull............140	Aldebaran.......1
3 Gemini.	The Twins. 85	Castor & Pollux.

Summer.

4 Cancer..	The Crab............83	Acubens..........1
5 Leo..................	The Lion.............95	Regulus..........3
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CHAPTER XXVII.

The Aurora Borealis; Zodiacal Lights; The Galaxy, or Milky Way.

Q. WHAT is meant by the Aurora Borealis?

A. By the aurora borealis, we mean those streaks of light, which in the polar regions, during the frost of winter are frequently seen in the sky.

Q. Can any reason be assigned for such appearances?

A. The aurora borealis has a resemblance to lightning, and its origin has been ascribed to electricity.

Q. Where is the aurora borealis seen with greater brilliancy?

A. It is seen with greater brilliancy in the northern latitudes, where its brightness exceeds the light of the Moon.

Q. Of what use is this light?

A. In the high northern latitudes, the aurora borealis supplies in a great measure the absence of the Sun.

Q. What is meant by zodiacal light?

A. The zodiacal light is a beam of light of a triangular form, seen before sunrise and after sunset, with the base toward the Sun.

Q. When is this light clearest?

A. About the beginning of March, in the evening, and in September, in the morning, the zodiacal light is clearest.

Q. What is the supposed cause?

A. The general opinion is, that the light proceeds from the Sun's atmosphere.

Q. What is the Milky Way?

A. The milky way is a whitish zone, nearly encircling the heavens.

Q. What is the cause?

A. Dr. Herschel, upon examining the milky way with a very powerful telescope, concludes, that the luminous appearance proceeds from the vast number of stars which it contains.

Q. How many stars have been observed?

A. In a part of the milky way, 15 degrees in length, and two in breadth, Dr. Herschel distinctly enumerated 50,000 stars.

CHAPTER XXVIII.

The Tides.

Q. What is meant by the tides?

A. The tides are two periodical motions of the waters of the ocean, called *flux* and *reflux.*

Q. How does the sea flow?

A. The water of the sea flows from south toward north, and entering the mouths of rivers, it drives back the water, and stops their current.

Q. How long does the influx continue?

A. The tides flow for the space of 6 hours, and seem to rest for 15 minutes, which time is called high water.

Q. What then takes place?

A. The ebb or reflux then begins, and continues for six hours, when the rivers resume their natural course.

Q. At the end of the reflux, what happens?

A. The waters rest for 15 minutes, which is called low-water, when the sea again begins to flow; thus the flux and reflux continue alternately.

Q. How many times does the tide ebb and flow every day?

A. The tide ebbs and flows twice every 24 hours.

Q. Does high-water always happen at the same time, in every place?

A. The time of high-water is every day 48 minutes later than on the preceding day.

Q. Why does this happen?

A. The tides happen later 48 minutes every 24 hours, because the Moon is 24 hours 48 minutes from leaving a meridian till she arrives at the same again; or because a lunar day is 48 minutes longer than ours.

CHAPTER XXIX.

Theory of the Tides.

Q. What is the cause of this motion of the waters?

A. The flux and reflux are occasioned by the attraction of the Moon and the Sun, but more especially of the former.

Q. How does attraction produce this flux and reflux?

A. The attraction of the Moon acting upon the water, which on account of its fluidity is more easily moved than the solid parts of the Earth, the water becomes elevated when that attraction exists.

Q. Where is the Moon when it is high-water at any place?

A. The Moon is on or near the meridian of the place, when it is high-water at that place, or else she is on or near the opposite meridian.

Q. When are the tides highest?

A. The tides are greatest at the new and full Moon.

Q. Why are they highest at those times?

A. The tides are highest at changes, because the Sun and Moon are in conjunction, and conspire to raise the waters, and occasion spring tides. See *Plate* II. *Fig.* G.

Q. When are the lowest tides?

A. The lowest tides happen when the Moon is in her first and last quarters. See *Plate* II. *Fig.* F.

Q. What is the cause?

A. When the Moon is in her quadratures, she is in opposition to the Sun; and the attraction of the one acts against that of the other; thus the Moon not only loses the assistance of the Sun to raise the waters, but finds him acting quite the contrary.

Q. At what season are the tides highest?
A. The tides are highest at the vernal and autumnal equinoxes.
Q. Why are they highest at those seasons?
A. The highest spring tides happen at the equinoxes, because the Sun is nearer the Earth in Summer than in Winter.
Q. How is it that it is high-water at the meridian directly opposite to the Moon?
A. It is high-water to us when it is at the opposite meridian, or 180 degrees distant, because the Earth turns on her axis, and the water rises by centrifugal force.
Q. By what force is it raised under the Moon?
A. The water rises as the Moon passes, by the Moon's centripetal force, or by the joint centripetal force of the Sun and Moon.

CHAPTER XXX.

Atmosphere; Wind; Rain, &c.

Q. What is the atmosphere?
A. The Earth's atmosphere is the air which surrounds the Earth to the height of 45 miles, and is the support of animal and vegetable life.
Q. Of what does it consist?
A. The atmosphere consists of nitrogen, oxygen, and carbonic acid gas.
Q. What is the weight of the atmosphere?
A. The weight of the atmosphere upon every square foot on the Earth's surface is 2160 pounds; but it becomes gradually thinner, so that at the tops of very high mountains it is difficult to breathe.

Q. What is Wind?

A. A current of air put in motion.

Q. What is the cause of its motion

A. When air is rarified by the heat of the Sun it becomes light, and rises, then the heavier air rushes in to supply its place, and produces wind.

Q. Why then does the wind change its direction?

A. It is owing to the change of the Earth's position with regard to the Sun; also to the influence of mountains, valleys, oceans, &c.

Q. How are the winds divided?

A. In Trade-winds, and Variable winds.

Q. Of how many kinds are the trade-winds?

A. They are of two kinds, the shifting trade-winds and the trade-winds.

Q. What are the shifting trade-winds?

A. The shifting trade-winds are those which blow one-half the year from the southwest and the other half from the northeast.

Q. Where do they prevail?

A. In the Indian Ocean.

T. Describe the Trade-winds.

P. They are those winds which always blow in the same direction; on the north of the equator from the east and northeast, on the south side from the east and southeast.

Q. Where do they prevail?

A. In the Atlantic and Pacific Oceans, between the equator and 25 degrees of north and south latitude.

Q. What are Variable winds?

A. Those which are continually changing from day to day, owing to the inequality of the Earth's surface.

Q. Where do they prevail?

A. Beyond the 40th degree of latitude.

Q. What are Land and Sea Breezes?

A. Those which blow a certain number of hours from the land, and then a certain number of hours from the sea. They prevail in the torrid zone.

Q. What are Vapors?

A. They are formed by watery particles, separated from the land or water by the action of the Sun; being lighter than the air, they rise and float in it.

Q. What are clouds?

A. They consist of vapors exhaled from the sea or land: when these vapors rise to a height where their density is equal to the surrounding air, they unite and become heavier.

Q. What is Rain?

A. When clouds become so condensed and heavy that the air cannot support them, they descend in the form of rain.

Q. Where does the most rain fall during the year?

A. At the equator; because the heat of the Sun being there the greatest, produces the greatest exhalations.

Q. What is Snow?

A. Snow is composed of vapors frozen while small, which being but little heavier than the air, descend with gentle motion to the earth.

Q. What is Hail?

A. It is composed of vapors condensed into drops, which by some sudden change in the atmosphere are frozen while falling.

Q. What are Fogs and Mists?

A. They are thin clouds resting on the surface of the earth.

Q. What is the Twilight?

A. The morning and evening twilight is the reflected light of the Sun through the medium of the atmosphere, when he is within 18 degrees of the horizon.

CHAPTER XXXI.

Of Globes.

Q. What is a Globe ?
A. It is a round body.
Q. How many kinds of globes are there ?
A. Two—*Terrestrial* and *Celestial.*
Q. What does the terrestrial globe represent ?
A. The figure of the Earth, with its oceans, continents, rivers, kingdoms, &c., delineated on its surface.
Q. What is represented on the celestial globe ?
A. On its surface are delineated all the appearances of the heavens.
Q. In viewing the representations on these globes, where is the eye supposed to be placed ?
A. On the surface of the terrestrial globe, and at the centre of the celestial.

PROBLEMS

PERFORMED BY THE

TERRESTRIAL GLOBE.

PROBLEM I.

To find the latitude of any given place.

Rule.—Bring the place to the graduated side of the brazen meridian, and the degree of the meridian over the place is the latitude.

Q. What is the latitude of London?
A. Fifty-one and a half degrees north.
Q. What is the latitude of St. Helena?
A. About sixteen degrees south.
Q. What places have no latitude?
A. The directly under the equator.
Q. Find all the places which have no latitude.
A. All places between the equator and south pole are in south latitude, and those between the equator and north pole are in north latitude.

Find the latitude of the following places:

Amsterdam,	Cape of G. H.	Halifax,
Aleppo,	Cape Horn,	Ispahan,
Athens,	Cario,	Lima,
Algiers,	Dantzic,	Lisbon,
Bengal,	Dublin,	Madrid,
Boston,	Edinburg,	Madras,
Batavia,	Fez,	Moscow,

New York,	Prague,	Teneriffe,
Norfolk,	Quito,	Tripoli.
Paris,	Rome,	Washington,
Philadelphia,	Stockholm,	Vienna.

PROBLEM II.

To find the longitude of any given place.

Rule.—Bring the place to the brazen meridian, and the degree of the equator under the meridian, is the longitude.

Q. What is the longitude of Washington?
A. About seventy-seven degrees west.
Q. What is the longitude of Madras?
A. Eighty degrees east.
Q. What is the greatest longitude a place can have?
A. One hundred and eighty degrees.
Q. How do you find all those places which have the greatest longitude?
A. Bring the one hundred and eightieth degree of the equator to the meridian, and all the places under the meridian have the greatest longitude.

Find the longitude of the following places:

Alexandria,	Calcutta,	Knoxville,
Archangel,	Cadiz,	London,
Aleppo,	Delhi,	Leghorn,
Albany,	Dresden,	Jerusalem,
Baltimore,	Damascus,	Montreal,
Berlin,	Gibraltar,	New Orleans,
Constantinople,	Havana,	Nankin,
Charleston,	Hamburg,	Oporto,
Canton,	Buenos Ayres,	Pekin,

Petersburg,	Rio Janeiro,	Toulouse,
Portsmouth,	Caraccas,	Venice,
Quebec,	Sierra Leone,	Vesuvius,
Rhodes,	Tunis,	Warsaw,
Syracuse,	Tyre,	Washington.

PROBLEM III.

The hour of the day at any place being given, to find what o'clock it is at any other place.

RULE.—Bring the place, where the hour is given, to the brazen meridian; set the index to the given hour; then turn the globe till the proposed place comes under the meridian; the index will point the hour required.

NOTE.—1. If the place required be to the east of the given place, it is later, if to the west, it is earlier.

NOTE.—2. If the place required be east of the given place turn the globe westward; if to the west, turn the globe eastward.

Q. When it is twelve o'clock at noon in London, what is the time at Mauritius and Philadelphia?

A. Four, P. M., at Mauritius, and seven, A. M., at Philadelphia.

Q. When it is eight o'clock A. M. at Boston, what is the time at Acapulco and Cape Farewell?

A. Six, A. M., at Acapulco, and ten, A. M., at Cape Farewell.

Q. When it is midnight at New York, what o'clock is it at

Paris,	Canton,	New Orleans,
Rome,	Calcutta,	Rio Janeiro,
Petersburg,	Cairo,	Ascension Islands?

Q. When it is noon at Lisbon, what is the hour at

Quebec,	Cape Horn,	Babelmandel,
Jerusalem,	Bermudas,	Botany Bay,
St. Helena,	Cape Comorin,	Athens,
Mexico,	Pekin,	Tripoli?

PROBLEM IV.

To find the distance in miles between any two places on the Globe.

Rule.—Lay the quadrant of altitude over both places, and it will show the number of degrees, which multiply by sixty-nine and a half, and it will give the distance in miles.

Q. What is the distance between London and Jamaica?

A. Sixty-seven and a half degrees, or four thousand six hundred and ninety-one miles.

Q. What is the distance between New York and Paris?

Q. What is the distance between Baltimore and London?

Q. What is the distance between
Cadiz and Petersburg,
Washington and Madrid,
Cape Horn and Good Hope,
Philadelphia and Venice,
New York and London,
Cuba and Cyprus,
Charleston and Fez,
London and Bombay?

PROBLEM V.

The day of the month being given, to find the Sun's place or longitude in the ecliptic and its declination.

Rule.—Look for the given day in the circle of months on the horizon, and opposite to it in the circle of signs, are the sign and degree the sun is in on that day. Find the same sign and degree in the ecliptic, and it will be the Sun's place or longitude; bring this place to the meridian, and you will have the declination.

Q. What is the Sun's longitude and declination on the twenty-second of February?

A. Its longitude is three hundred and thirty-seven and a half degrees, or four and a half degrees in Pisces; its declination is ten degrees south.

Q. What is the Sun's longitude and declination on the fifteenth of April?

A. Its longitude is twenty-five and a half degrees in Aries; its declination is ten degrees north.

Q. What is the Sun's declination on the twenty-first of June?

Q. What is the Sun's place and declination on the twenty-second of December?

Q. What is the Sun's place in the ecliptic, and its declination, on each of the following days?

March 30th,	September 16th,
April 4th,	October 5th,
May 12th,	November 2d,
June 9th,	December 29th,
July 13th,	January 7th,
August 8th,	February 16th,

PROBLEM VI.

To rectify the globe for the Latitude, Zenith, and Sun's place on any day.

1. For the Latitude. Elevate the pole till the horizon cuts the brass meridian in the degree corresponding to the latitude of the place.

2. The place given is then in the Zenith.

3. Then (by Problem V,) find the Sun's place for the given day, bring it to the meridian, and set the index to twelve.

Note.—If the place be in north latitude, elevate the north pole, if in south latitude, elevate the south pole.

1. Rectify the globe for the latitude of London on the tenth of May.

In this case elevate the north pole fifty-one and a half degrees, then London will be in the zenith; over it screw the quadrant of altitude; the tenth of May on the horizon answers to the twentieth degree of Taurus, which find on the ecliptic, and bring it to the meridian, and set the index to twelve. This is the position of the globe as it appears to the inhabitants on the tenth of May.

2. Rectify the globe for

New York,	12th January,
Boston.	6th February,
Constantinople,	9th March,
Petersburg,	10th April,
Madrid,	16th September,
Cape Horn,	15th November,
St. Jago, (Chili)	14th December,
Gallipagos,	19th October.

PROBLEM VII.

To find at what hour the Sun rises and sets at any place, any day in the year, and the length of the day and night at that place.

Rule.—1. Rectify the globe (by Problem VI,) for the latitude of the place; find the Sun's place in the ecliptic (by Problem V,) and bring it to the meridian, and set the index to twelve; bring the Sun's place to the eastern edge of the horizon, and the index will show the hour of rising; bring it to the western edge of the horizon, and the index will show the hour of setting.

2. Double the time of sun rising, and it will give the length of the night; double the hour of sun setting, and it will give the length of the day.

Q. What time does the sun rise and set at New York on the tenth of May, and what is the length of the day and night?

A. It rises fifty-six minutes past four; sets four minutes past seven; length of the night nine hours fifty-two minutes; of the day fourteen hours eight minutes.

Q. What is the time of sun rising and sun setting, and the length of the day and night, at each of the following places on the day mentioned?

Washington city,	4th of May,
Constantinople,	14th of June,
London,	15th of July,
Rio Janeiro,	8th of September,
Cape Horn	1st of December,
Rome,	5th of January,
Naples,	9th of October,
Canton,	8th of August,
Boston,	7th of November?

PROBLEM VIII.

The month and day of the month being given, to find those places where the Sun does not set, and where it does not rise on the given day.

Rule.—Find the Sun's declination (by Problem V,) elevate the pole for the declination in the same manner as for the latitude ; turn the globe on its axis, and on the places round the pole above the horizon the Sun does not set ; and on the places round the other pole below the horizon the Sun does not rise, on that day.

Q. How much of the south frigid zone is darkened, and how much of the north frigid zone is enlightened, on the twentieth of May ?

A. Twenty degrees round each pole.

Q. On which pole does the Sun rise on November the sixth ?

Q. Which frigid zone, and how much of it, has constant day on August 4th ?

Q. How much of the south frigid zone has constant day on the following days :

October	1st,	January	9th,
October	20th,	February	10th,
November	19th,	February	20th,
December	22d,	March	1st?

Q. What days in the year does the Sun shine equally on both poles ?

CELESTIAL GLOBE.

PROBLEM I.

To find the right ascension of the Sun or a star.

Rule.—Bring the Sun's place in the ecliptic or the star, to the brass meridian, then the degrees of the equinoctial under the meridian, reckoning from Aries eastward, is the right ascension.

Note.—The Sun's place in the ecliptic is found by Problem V, *Terrestrial Globe.*

Q. What is the Sun's right ascension on the 19th of April?

A. Twenty-seven and a half degrees.

Q. What is the Sun's right ascension on the 1st December?

A. Two hundred and forty-seven degrees fifty minutes.

Q. What is the Sun's right ascension on—

November	6th,	May	7th,
March	4th,	August	10th,
April	20th,	September	14th,
June	16th,	October	23d,
July	29th,	December	10th?

Q. What is the right ascension of Aldebaran?

A. Sixty-six degrees six minutes.

Q. What is the right ascension of—

Alioth,	Castor,	Menkar,
Arcturus,	Algol,	Pleiades,
Achernar,	Fomalhaut,	Procyon,
Bellatrix,	Hyades,	Regulus,

Rastaben,	Sirius,	Pollux,
Rigel,	Antares,	Acubens?

NOTE.—The preceding stars, and their planes in the constellations, may all be found in the preceding table.

PROBLEM II.

To find the declination of the Sun or a star.

RULE.—Bring the Sun's place in the ecliptic or the star, to the brass meridian, and the degree of the meridian over that place will be the declination.

Q. What is the declination of the Sun, April 19th?
A. Eleven degrees nineteen minutes north.
Q. What is the Sun's declination,

January	18th,	April	12th,
February	12th,	May	23d,
March	2d,	June	21st?

Q. What is the declination of Aldebaran?
A. Sixteen degrees six minutes.
Q. What is the declination of—

Atair,	Arcturus,	Regulus
Algenib,	Procyon,	Rigel?

PROBLEM III.

The latitude of the place, the day and hour being given, to place the globe so as to represent the appearance of the heavens at that time at the place; and to point out the situations of the several stars.

Rule.—Elevate the pole for the latitude of the place; find the Sun's place in the ecliptic, and bring it to the meridian, and set the index to 12; if the time be afternoon turn the globe westward, if in the forenoon, turn it eastward, till the index points to the given hour. The surface of the globe then represents the appearance of the heavens at that place.

Q. Represent the appearance of the heavens for January 13th, 4 o'clock, A. M., and 8 o'clock P. M.

PROBLEM IV.

To find the latitude or longitude of a given star.

Rule.—Screw the quadrant on the pole of the ecliptic, bring the star to the meridian, and the degrees of the quadrant between the ecliptic and star, show the latitude, and the degree of the ecliptic under the graduated edge of the quadrant is the longitude.

Q. What is the latitude and longitude of Arcturus?
A. Latitude thirty-one degrees north, longitude two hundred and one degrees.
Q. What are the latitudes and longitudes of—

Fomalhaut,	Canis Major,
Canis Minor,	Regulus?

PROBLEM V.

The latitude and longitude of a heavenly body being given, to find its place on the globe.

Rule.—Fix the quadrant as in the last problem, and place it on the given degree of longitude in the ecliptic; then seek the given latitude on the quadrant, and under that degree is the place sought.

Q. What is the star whose longitude is two hundred and one degrees, and its latitude thirty-one degrees north?

A. Arcturus in Bootes.

Q. What stars have the following longitudes and latitudes?

Longitudes.	Latitudes.
$66\frac{1}{2}$ degrees,	$5\frac{1}{2}$ degrees south,
299 degrees,	29 degrees north,
85 degrees,	16 degrees south.

PROBLEM VI.

The right ascension and declination of a heavenly body being given, to find its place on the globe.

Rule.—Bring the given right ascension to the brass meridian, and under the given degree of declination on the meridian, is the place required.

Q. What is the star, whose declination is thirty degrees forty minutes south, and right ascension three hundred and forty-one degrees thirty-eight minutes?

A. Fomalhaut in the Southern Fish.

Q. What are the stars whose right ascension and declinations are as follows:

Right ascension.	Declination.
183° 44′	69° 59′ south,
277° 32′	38° 39′ north.

APPENDIX,

CONTAINING

ASTRONOMICAL TERMS.

Aberration, is an apparent change of place in the fixed stars, arising from the motion of the Earth combined with the motion of light.

Achronical, rising or setting of a planet or star, is, when it rises at sunset, or sets at sunrise.

Altitude, is the height of the Sun, Moon, or stars, above the horizon.

Amplitude, is an arc of the horizon, contained between the true east or west point of the heavens, and the centre of the Sun or star, at its rising or setting.

True Anomaly, is the distance of a planet in signs, degrees, &c., from that point of its orbit which is the farthest from the Sun.

Antœci, is a name given to those inhabitants of the Earth, who live under the same meridian, and at equal distances from the equator, but opposite sides of it.

Antecedentia, is a motion of any of the heavenly bodies, which is contrary to the order of the signs: as, from Aries toward Pisces, &c.

Aphelion, is the place in a planet's orbit when farthest from the Sun.

Apogeon, is that point in a planet's orbit at its greatest distance from the Earth.

Apsides, are two points in a planet's orbit, in which it is at its greatest and least distance from the Sun; the line joining those points, is called the line of the Apsides.

Ascensional Difference, is an arc of the equinoctial, contained between that point of it which rises with the Sun, Moon or star, and that which comes to the meridian with them; or, it is the time the Sun rises or sets before or after six o'clock.

Atmosphere, is that body of air which surrounds the Earth.

Attraction, according to the Newtonian philosophy, is that innate principle of matter, by which bodies mutually tend toward each other.

Axis of the Earth, or of a planet, is an imaginary line passing through the centre from one pole to the other; or that round which they are supposed to perform their diurnal rotations.

The *Azimuth* of any celestial object, is an arc of the horizon contained between the east or west point of the heavens, and a vertical circle passing through the centre of that object.

Cardinal Points, are the east, west, north, and south points of the compass.

Cardinal Points of the ecliptic, are the first points of the signs Aries, Cancer, Libra and Capricorn.

Conjunction, is when two stars seen from the Sun or the Earth, appear at the same point of the heavens, or answer to the same degree of the ecliptic.

Cosmical rising or setting of a planet or star, is when it rises with the Sun in the morning, or sets with him in the evening.

Culminating, is a term applied to the Sun, or a star when it comes to the meridian of any place.

Cycle of the Moon, is a revolution of 19 years; in which time the conjunctions and lunar aspects are nearly the same as they were 19 years before.

An Astronomical Day, the time between two successive transits of the Sun's centre over the same meridian; which always begins and ends at noon.

Declination of the Sun, Moon, or stars, is their distance north or south from the equator, reckoned in degrees, minutes, &c., upon a circle which is perpendicular to it.

Direct, a planet is said to be direct, when it moves according to the order of the signs; as from Aries toward Taurus, &c.

Disc of the Sun or Moon, is its round face; which, on account of the great distance of the object, appears flat or like a plane surface.

Digit, in astronomy, is the twelfth part of the Sun's diameter, which is often used in the calculation of eclipses.

Eccentricity, is the distance between the centre of an ellipsis and either of its foci.

Elongation, is the angular distance of a planet from the Sun, as it appears to a spectator upon the Earth.

Elements, in astronomy, are the requisites necessary to determine the theory of a planet, in order to calculate its position, motion, &c.

Emersion, is the time when any planet which is eclipsed begins to recover its light again.

Epact, is the Moon's age at the end of the year: or the difference between the solar year and the lunar one.

The *Equator*, is a great circle which separates the northern from the southern hemisphere, consisting of twelve stars.

The *Equinoxes*, are two points where the ecliptic cuts the equator; so called, because when the Sun is in either of these situations, the days and nights are equal to each other.

Erection, is an inequality in the motion of the Moon, by which at her quarters, her mean place differs from her true one by about 2½ degrees more than at her conjunction and opposition.

The *Galaxy* or milky-way, is a large irregular zone, or band of light, which encompasses the heavens.

The *Geocentric* place of a planet, is that position which it has when seen from the Earth.

Gibbous, is a term used in reference to the enlightened parts of the Moon, whilst she is moving from the first quarter to the full, and from the full to the last quarter, on account of the dark parts appearing falcated, or horned, and the light ones convex.

Golden Numbers, a series of numbers proceeding from one to nineteen, which are used in the almanac, for determining the times of new and full moons.

Heliacal rising of a star, is when it emerges from the Sun's rays, and appears above the horizon before him in the morning.

Heliacal setting of a star, is when it is so hidden in the Sun's beams, as not to be seen above the horizon after him in the evening.

Heliocentric place of a planet, is that in which it would appear to a spectator placed in the Sun.

Hesperus, a name given to the planet Venus, when she appears in the evening.

Heteroscii, a name given to the inhabitants of the temperate zones, because their shadows at noon always fall one way.

The *Sensible Horizon*, is a circle which separates the visible hemisphere from the invisible one, or that which is the boundary of our sight.

The *Rational Horizon*, is a great circle which is parallel to the former, and the two poles of which are the zenith and nadir.

An *Immersion*, is the moment when an eclipse begins, or when a planet enters into the dark shadow.

Inclination, is the angle which the orbit of one planet makes with that of another.

The *Inferior Planets*, are those which move at a less distance than the Earth from the Sun.

Ingress, is the Sun's entrance into any sign, or other part of the ecliptic.

An *Intercalary Day*, is the odd day, which is made up of the six hours every fourth, or leap-year.

Julian Year, the account of time instituted by Julius Cæsar, which is now called the old style.

The *Latitude* of a star or planet, is its distance from the ecliptic, reckoned in degrees, minutes, &c., upon the arc of a great circle which is perpendicular to it.

Leap Year, is the same with bessextile; so called, from their being a day more in that year than in a common one.

Libration, an apparent irregularity of the Moon's motion, which makes her appear to librate about her axis in such a manner that the parts of her eastern and western limbs become visible and invisible alternately.

The *Longitude* of a star or planet, is its distance from the first point of Aries, reckoned in degrees, minutes, &c., upon the equator.

Lucifer, is the morning star Venus; so called, when it is in the east, and rises before the Sun.

Lunar Aspects, are those which the Moon makes with any of the other planets; as when she comes into opposition, trine, quartile, &c.

The *Maculæ*, are dark spots, appearing on the face of the Sun, Moon, and some of the planets; being contradistinguished from *faculæ*, which are bright or shining spots, that, by means of the telescope, are sometimes to be seen on the face of the Sun, &c.

The *Magnitudes* of the stars are divided into six by some, by others into eight sizes, or classes; of which the brightest are called stars of the first magnitude, about four times less than the Earth.

The *Mean* motion of a planet, is that which would take place, if it moved in a perfect circle, and equally every day.

A *Meridian*, is a great circle of the sphere, which passes through the zenith and poles.

A *Minute*, is the 60th part of an hour in time, or of a degree in motion.

A *Lunar*, or *Periodical Month*, is a period of about 27 days 7 hours and 43 minutes, which is the time the Moon is in passing from one point of her orbit, to the same point again.

A *Synodical Month*, is a period of about 29 days and a half, which is the time between one conjunction of the Sun and Moon and another.

A *Solar* or *Calendar Month*, is the time the Sun takes to move through one of the signs of the zodiac, which, at a mean, is about 30 days and a half.

Nebulæ, are clusters of small stars which have been discovered by the telescope in different parts of the heavens; and are so called from their cloudy appearance.

A *Nocturnal Arc*, is that space of the heavens which the Sun apparently describes, from the time of his setting to the time of his rising.

Nodes, are two points where the orbit of a planet intersects the plane of the ecliptic.

Nucleus, is a term used by some Astronomers, for the head of a comet; and by others for the central parts of the planets.

Oblique Ascension, is an arc of the equinoctial, contained between the first degree of Aries, and that point of it which rises with the centre of the Sun or a star.

Occultation, is when a star or planet is hidden from our sight by the interposition of the Moon, or some other planet.

Opposition, is an aspect of the stars or planets, when they are 180 degrees distant from each other.

Orbit of a planet, is the curve or path which it describes in its revolutions round the Sun.

Parallax, is the difference between the places of any celestial object, as seen from the surface of the Earth and from its centre.

Parallax of the Earth's annual orbit, is the angle at any planet which is subtended by the distance between the Sun and Earth; or, it is that change of place in the planets, which arises from their being seen from different points of space, as the Earth moves round the Sun.

Penumbra, is a faint shadow, which accompanies an eclipse, and occasions a partial obscurity of the body to that part of the Earth on which it falls.

Periœci, are those inhabitants of the Earth who live under the same parallels of latitude, but on opposite sides of the meridian.

Perigeon, is that point of a planet's orbit in which it is at its least distance from the Earth.

Perihelion, is that point of a planet's orbit in which it is at its least distance from the Sun.

Phases, are the several appearances of the Moon and planets, according as a greater or less part of their illuminated hemispheres is presented to our sight.

The *Primary Planets*, are those bodies in our system, which regard the Sun as the centre of their motions.

Plane, in astronomy, is frequently used for an imaginary surface, which is supposed to cut and pass through solid bodies; and, in this sense, we are to understand the plane of a planet's orbit.

Precession of the equinoxes, a slow motion of the two points where the equator intersects the ecliptic, which are found to go backwards about 50 seconds a year.

Quadratures, or quarters, are those phases of the Moon which take place between the conjunction and opposition, and between the opposition and conjunction; one being called the first quarter and the other the third.

Quartile, is an aspect of the planets when they are 90 degrees, or a quarter of the zodiac distant from each other.

Refraction, is that variation which the rays of light suffer in passing through the mediums of different densities which occasions the heavenly bodies, when viewed obliquely through the atmosphere, to appear at a greater height above the horizon than they really are.

Repulsion, is that property in bodies, by which, if they are placed just beyond the sphere of each other's attraction of cohesion, they mutually fly from each other.

Retrograde, is an apparent motion of the planets in some parts of their orbits, when they seem to go backwards, or contrary to the order of the signs.

Revolution, is that motion by which the heavenly bodies, in a certain time, return again to the same points of their orbits.

Rotation, is the motion of any heavenly body round its axis.

The *Seasons*, are Spring, Summer, Autumn, and Winter.

Sextile, is an aspect of the heavenly bodies when they are 60 degrees distant from each other.

Sidereal Year, is that space of time which the Sun takes in moving through the ecliptic, from any fixed star to the same star again.

The *Signs*, are the twelve constellations of the zodiac: Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏, Sagittarius ♐, Capricornus ♑, Aquarius ♒, and Pisces ♓.

Solstitial Points are the two points of the zodiac, Cancer and Capricorn; at which the ecliptic touches the tropics, and into which the Sun enters on our longest and shortest days.

Southing of the stars, is the time when they culminate or come to the meridian.

Superior Planets, are those those which move at a farther distance from the Sun than the Earth; as Mars, Jupiter, Saturn, and Herschel.

Synodical Month, is the space of time from any new Moon to the following one, which is at a mean 29 days, 12 hours and 45 minutes.

Syzygies, are those points of the Moon's orbit in which she is at the time of her new and full.

The *Telescopic Stars*, are those which are only discoverable by means of a telescope.

Transit, is the passing of one celestial body before another; so as to render any part of it invisible.

Trine, is an aspect of the planets, when they are 120 degrees distant from each other.

Twilight, is that faint light which we perceive before the rising of the Sun, and after his setting, and which is occasioned by the refraction of the Earth's atmosphere.

Vertical Circles, are the same as azimuth circles, or such as are drawn perpendicular to the horizon.

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