A

NEW MANUAL

OF THE

ELEMENTS OF ASTRONOMY,

DESCRIPTIVE AND MATHEMATICAL:

COMPRISING

THE LATEST DISCOVERIES AND THEORETIC VIEWS,

WITH DIRECTIONS FOR THE

USE OF THE GLOBES, AND FOR STUDYING THE CONSTELLATIONS.

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CHAPTER II.

THE PLANETS.

13. There are eight large primary planets in the solar system, besides a great number of smaller ones, called MINOR PLANETS, or ASTEROIDS.*

14. The names of the eight large primary planets, in the order of their distances from the sun, are Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

15. All the primary planets except the earth are divided into two classes, INFERIOR and SUPERIOR PLANETS.

16. Mercury and Venus are called inferior planets, because they revolve within the orbit of the earth; Mars, Jupiter, Saturn, Uranus, and Neptune are called superior planets, because they revolve beyond the orbit of the earth. Instead of the terms inferior and superior, *interior* and *exterior* are sometimes used.

a. **Vulcan.**—A planet inferior to Mercury has been supposed to exist; and in 1859, a French astronomer was thought by some to have discovered it. Later observations have not, however, confirmed, but rather disproved, its existence. The name given to this supposed planet is *Vulcan.*

17. The MINOR PLANETS are very small planets which revolve around the sun, between the orbits of Mars and Jupiter. *Ninety-six* have been discovered (1868).

a. These small planets were at first, and have been, very generally, called **Asteroids**; they have also been called **Planetoids.** The name

* From the Greek *aster*, meaning *a star*, and *eido*, to resemble.

QUESTIONS.—13. How many primary planets in the solar system? 14. What are the names of the large planets? 15. How divided? 16. Which are called inferior? Which superior? Why? *a.* Vulcan—what is said of it? 17. What are the minor planets? Their number? *a.* What other names are applied to them?

CHAPTER XII.

THE INFERIOR PLANETS.

I. MERCURY. ☿

205. MERCURY is remarkable for its small size, its swift motion, and the great inclination and eccentricity of its orbit. It is, as far as is positively known, the nearest planet to the sun.

a. **Name and Sign.**—This planet probably derived its name from the swiftness of its motion, Mercury being, in the heathen mythology, the "messenger of the gods." The sign ☿ is supposed to represent the *caduceus,* or wand, which the god is always seen, in the pictures of him, to carry in his hand.

b. **Vulcan.**—Reference is made in Art. 16 to a planet supposed by some to exist between Mercury and the sun; the following are the circumstances connected with its supposed discovery:—On the 26th of March, 1859, a small dark body was seen to pass over a portion of the sun's disc, by M. Lescarbault, a French physician, but an amateur of astronomy; and this appeared to him to indicate the existence of a planet whose orbit must be included within that of Mercury. From the observations which he made with his rude instruments, he calculated its period at about 20 days; its distance, 14,000,000 miles; and the inclination of its orbit, about 12°. On publishing this fact, the celebrated French astronomer and mathematician, Leverrier, visited him, and after closely questioning him as to his means and method of observation, was completely satisfied of the truth of his statements. Singular to say, however, no other observer has been able to detect any indications of such a planet; but, on the contrary, M. Liais, an

QUESTIONS.—205. For what is Mercury remarkable? *a.* Its name and sign? *b.* Supposed discovery of Vulcan?

astronomer of skill and experience, who happened to be engaged in observations of the sun, at Rio Janeiro, at the identical moment of M. Lescarbault's alleged discovery, asserted positively that no planetary object was visible at that time. The existence of any planet inferior to Mercury is therefore considered very doubtful.

206. Mercury and Venus are known to be inferior planets, 1. Because their greatest elongation is always less than 90°; 2. Because they exhibit all the different phases which are presented by the moon; and, 3. Because they are seen, at the time of a transit, to pass across the sun's disc.

a. A superior planet also exhibits phases, but it must always show more than half the disc; that is, it must present the full or gibbous form. An inferior planet, however, in passing between the points of extreme elongation, presents the crescent form, and, in inferior conjunction, either totally disappears or is projected, in the form of a small round black spot, upon the disc of the sun.

207. The greatest angular distance of an inferior planet from the sun, during any single revolution, is called its *extreme elongation*. The greatest extreme elongation of Mercury is $28\frac{1}{4}°$; the least, 18°.

a. This large variation in the extreme elongation is an indication that Mercury revolves in an orbit of considerable ellipticity, since this angle depends upon the relative distances of Mercury and the earth from the sun. It must be greatest when the earth is in perihelion and Mercury in aphelion, and least when the earth is in aphelion and Mercury in perihelion; while the mean distance of each would give the mean value of this element.

In Fig 93 let S be the sun, E, the earth, and M, Mercury at the point of extreme elongation, M E being tangent to the orbit, and S M E a right angle. It will be obvious that M E S, the angle of extreme elongation, will be at its maximum when S E is the shortest and S M the longest; and at its minimum when these are reversed; because its size depends upon

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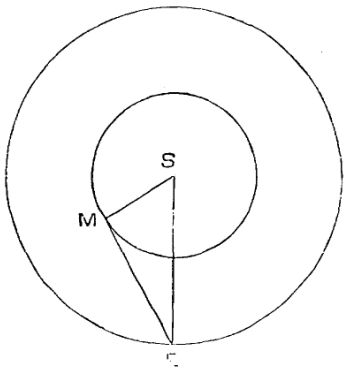
QUESTIONS.—206. How are Mercury and Venus known to be inferior planets? *a.* What phases do the inferior and superior planets present? 207. Extreme elongation? What is it in the case of Mercury? *a.* Why so variable? Give the calculation from the diagram.

the ratio of S M to S E, being greatest when the ratio is greatest. The perihelion distance of the earth is about 90,000,000 miles, the aphelion distance of Mercury is about 42,600,000 miles. For these values the ratio of S M to S E would be about .473; and the angle corresponding to this is 28° 15′. The least ratio of these lines is .3, and hence, the least angle, 18°; while the mean ratio is .387 (nearly), indicating an angle of 22° 47′, which is therefore the mean value of this element.

Fig. 93.



208. The aphelion distance of Mercury from the sun is about 42,600,000 miles; its perihelion distance, 28,100,000 miles; and its mean distance, therefore, nearly 35,400,000 miles.

a. **The Distance Calculated.**—The distance of an inferior planet can be determined by its extreme elongation; for (Fig. 93) S M is equal to S E multiplied by the sine of the angle S E M. Now, if the angle is 28° 15′, its sine (or ratio of S M to S E) will be .473, and hence, taking the perihelion distance of the earth, $90{,}000{,}000 \times .473 = 42{,}600{,}000$, which is the aphelion distance of Mercury.

b. The mean distance of any planet from the sun can be calculated by Kepler's third law, when we know the sidereal period. In the case of Mercury, this is very nearly 88 days; and hence, as *the squares of the periodic times are in proportion to the cubes of the mean distances,* $(365\frac{1}{4})^2 : (88)^2 :: (91{,}500{,}000)^3$: the cube of the mean distance of Mercury, which, if the proportion be worked out and the cube root extracted, will give 35,400,000 (nearly); and this is the true value of this element. [If the pupil is sufficiently advanced, it will be well for the teacher to show how this calculation may be facilitated by employing a table of common logarithms.]

c. The difference between the aphelion and perihelion distances of Mercury, it will be seen, is 14,500,000; hence its eccentricity is 7,250,000 miles, which is nearly .205 of its mean distance, or about 12 times as great as that of the earth.

Questions.—208. What are the aphelion, perihelion, and mean distances of Mercury? *a.* How calculated? *b.* How determined by Kepler's third law? *c.* Eccentricity—how found?