Name: _____

Exercise Thirteen: Indoor

The Planets, Part I: Analysis of Observations

The nine planets of our solar system are usually divided into two groups; the terrestrial planets and the Jovian planets. The terrestrial planets (Mercury, Venus, Earth, Mars, and Pluto) are those most like the Earth; they are relatively small, dense planets composed mostly of rocky and metallic material. The Jovian planets (Jupiter, Saturn, Uranus, and Neptune) are larger and of rather low density. (In fact, Saturn would float if there were a large enough pool of water.) The Jovian planets are probably composed mostly of hydrogen and helium. Planets closer to the Sun than Earth is (the inferior planets) show phases in a telescope. Superior planets don't.

I. The Terrestrial Planets

1. Take a look at several photographs and drawings of Venus (Figures 13.1 through 13.4). What do you first notice about the changing appearance of this planet—that is, something analogous to the changing appearance of the moon? How are Mercury (Figure 13.21) and Mars similar or different in this respect?

2. The amount of energy a planet receives from the sun is inversely proportional to the square of its distance from the sun. What effect might this have on the relative surface properties of the terrestrial planets? In what way does this significantly affect you?

3. What observations do you think have been made to establish that Venus has an appreciable atmosphere? Again, take a look at Venus in Figures 13.1 through 13.4.

4. a. Examine several of the Earth-based photographs of Mars (Figures 13.5 and 13.6). What sort of general features do you observe? Do you notice any evidence for seasonal variations on Mars? If so, what?

   b. Now examine the photograph taken by the Viking Orbiter (Figure 13.7) and the Mars maps prepared from Mariner 9 data (Figures 13.8, 13.9, and 13.10). What sort of features do you observe? The Martian surface resembles the surfaces of which other celestial bodies? What do the Martian surface features tell us about the Martian atmosphere?

   c. What sort of earthbound observations do you think can be made to establish that Mars has any atmosphere at all?

II. The Jovian Planets

1. a. Examine the several photographs of Jupiter (Figures 13.11, 13.12, and 13.13). Do you think that we are looking at a solid surface of Jupiter or at the upper layers of its atmosphere? Explain. What kind of observations would help us to determine whether we are looking at atmospheric phenomena or at a solid surface?

   b. What do you notice about the shape of Jupiter? How might this shape be explained?

   c. Notice the bands (of different colors) running across the disk of Jupiter. How might these bands be related to the motion of Jupiter?

   d. On several of the photographs of Jupiter, you can see a boat-shaped feature (that is reddish in color). This is called the Great Red Spot. How might one use this spot to determine the sidereal rotation period of Jupiter?

   e. Figure 13.14 shows the remarkable telescopic sketches of the surfaces of the four Galilean satellites of Jupiter by Lyot (an astronomer at the French observatory Pic du Midi). Compare the Voyager maps of the Galilean moons (Figures 13.15, 13.16, and 13.17) to the Lyot sketches. On the rough scale of Lyot's sketches, are they similar or different? Could telescopic sketches be of use in evaluating changes on Io?

2. a. Saturn, which is the sixth planet from the sun, has a beautiful set of rings around it (Figure 13.18). Can you suggest how these rings might have been formed? (Consider gravitational tidal forces.)

   b. Between Saturn's outer two rings is a gap known as Cassmi's division (Figures 13.19 and 13.20). Can you think of a mechanism by which this gap was created? (Again, consider gravitational forces.)

   c. Do you think that Saturn's composition and internal structure are similar to or different from Jupiter's? Why?

3. Unlike other planets, Uranus's axis of rotation lies almost in the plane of its orbit. How would this affect its seasons and the length of its days (or nights)?

III. The General Properties of the Solar System

1. Why do you think that the planets are all nearly spherical in shape and have very dense cores? (Consider gravity.)

2. All the planets revolve about the sun in a counterclockwise direction as viewed from the north, and the sun and all the planets (except Venus, Uranus, and Pluto) have axial rotations that are counterclockwise. Also, most of the natural satellites revolve about their respective planets in this same direction. The orbital planes of all of the planets lie nearly in the ecliptic plane, and, except for Uranus and Pluto, the equatorial planes of the planets are inclined less than 30° to their orbital planes. How would you explain this regular behavior of the solar system objects?

3. In a gas the following relation holds: $V^2 = 3kT/m$, where V^2 is the square of the average speed of the molecules, T is the temperature of the gas, m is the mass of one molecule, and k is a constant. For a planet, the escape velocity is given by the formula $V^2_{\text{escape}} = 2GM/R$, where G *is* the gravitational constant, M is the mass of the planet, and R is the planet's radius. Use these two equations to explain why the atmospheres of different planets have different compositions.