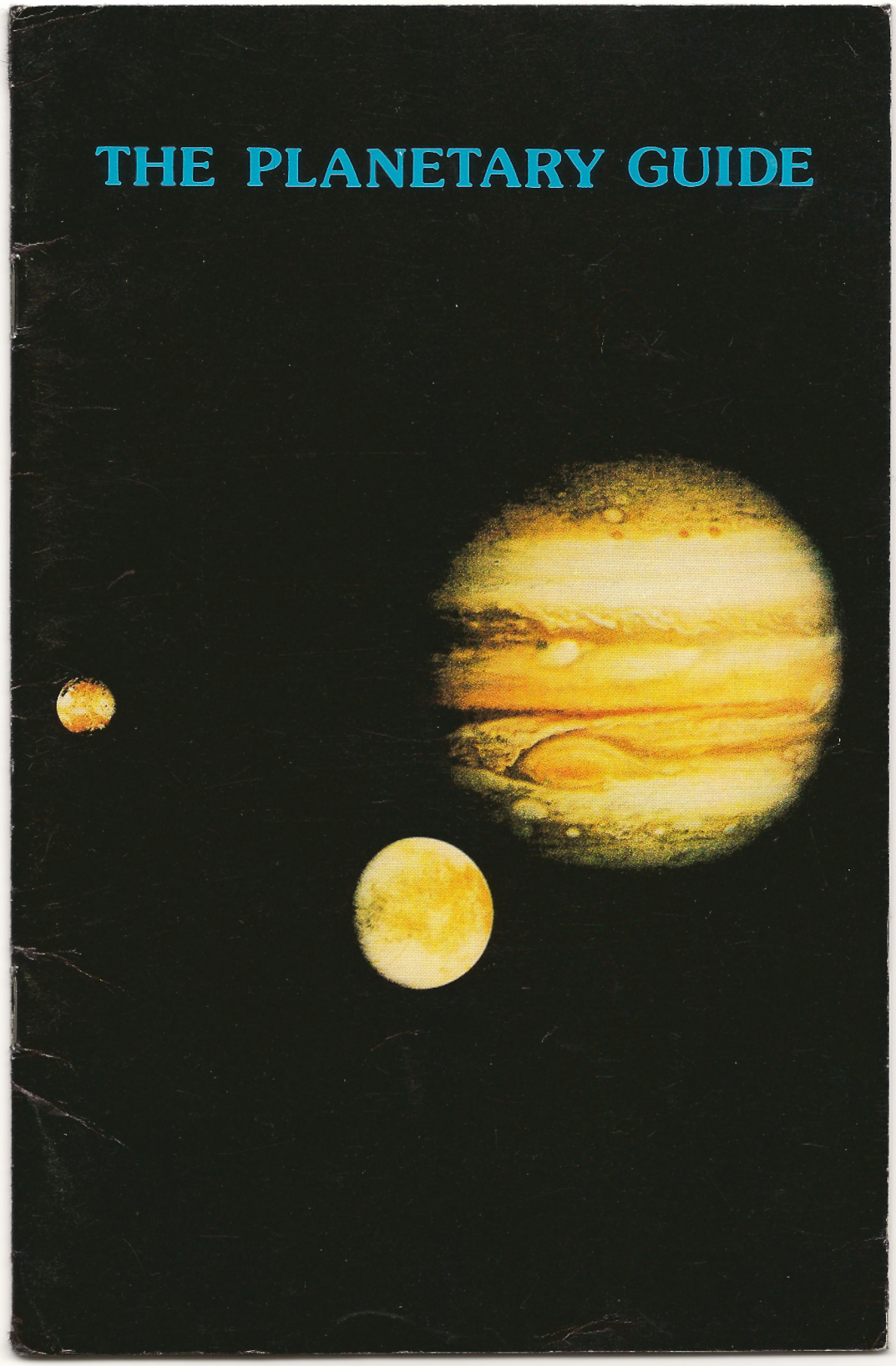
THE PLANETARY GUIDE



THE

PLANETARY GUIDE

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THE PLANETARY GUIDE

SECTION I INTRODUCTION

The Planetary Guide presents an overview of the members of our solar system as well as their complex interrelationships in a clear and convenient manner. Within the program you will find sets of data ranging from information on individual planets and their moons, comets, and asteroids, to illustrations of complex orbital relationships, to lunar and solar information. The first thing you will see when you run the program is the Planetary Guide Main Menu. (See Fig. 1.) From this you choose which set of data to view.

The program provides graphic images of each of the planets showing their general appearance, tables of statistics about each, and descriptive information about them. Graphic illustrations of the relative sizes of the planets, and illustrations which compare their orbits are also presented within sections clearly labeled. Alternative viewing choices, e.g. one planet at a time or all planets, are available.

Another section includes information on comets, asteroids, the sun, and the moon. Illustrations of the phases of the moon and the movement of comets around the sun will aid you in the understanding of these phenomena. The motion of the planets as they orbit the sun is illustrated in a later section. Retrograde motion is diagrammed starting from a date you will choose; planetary positions in the sky may be displayed for any date from the year 1 A.D. to beyond the present time.

After using The Planetary Guide, you will find it easy to locate and identify the planets in the night sky. All planets are visible to the naked eye except Uranus, Neptune, and Pluto.

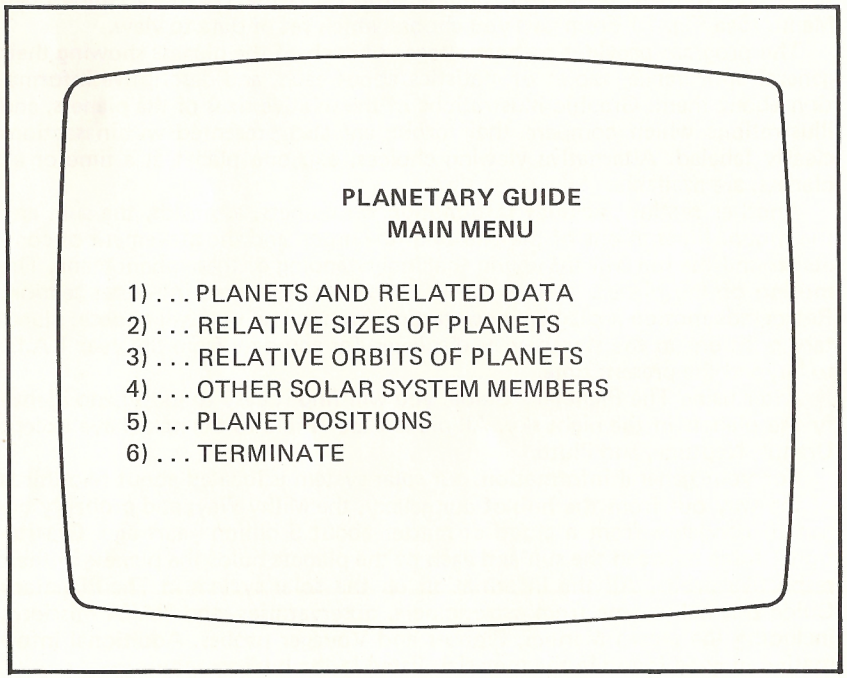
For your general information, our solar system is located about two-thirds of the way out from the hub of our galaxy, the Milky Way, and probably began to condense from a cloud of matter about 5 billion years ago. Gravitational force between the sun and each of the planets holds the planets in their respective orbits. All the information on the solar system in The Planetary Guide originally came from astronomers, observatories, and NASA missions, including the recent Mariner, Pioneer and Voyager probes. Additional information may be found in the materials listed in the bibliography.

SECTION II GETTING STARTED

The Planetary Guide requires an Apple II with Applesoft firmware, 48K RAM, and one disk drive. The programs are on a DOS 3.3 format disk. To begin using The Planetary Guide, insert and boot the disk. Boot according to the directions in the DOS (Disk Operating System) 3.3 manual. The disk must remain in the drive while using the program. For accidental RESETS the best procedure is to re-run the section by typing "RUN", then pressing RETURN. If this does not work, re-boot the disk.

The Planetary Guide Main Menu will appear on the screen. Enter your selection from the Main Menu by pressing the number in front of the section you have chosen. After that, you will see the option list for that particular section. From any of the section options on the Main Menu, it is not necessary to press RETURN after an entry. (Pressing RETURN may be necessary *within* some sections when entering an item that could possibly contain more than one character. Direction to press RETURN will appear on the screen in these cases.)

Figure 1
Main Menu



SECTION III USING THE PROGRAM

Following The Planetary Guide sections in the order listed provides a certain continuity of information, but sections can be viewed in any order desired. At every point where you make a choice of section or sub-section, the program will list available choices clearly—you press the desired key.

Menu Item 1: Planets and Related Data

After entering this option you will see a listing of the nine planets. Press the number of the planet about which you wish to learn, and an image of that planet appears on the screen along with its universal symbol. (See Figure 2 for a listing of symbols.) Press the space bar for information about the planet and its table of statistics. This table gives physical characteristics of each planet, such as size, orbital period, etc. Studying this data gives some idea of the great disparity among the planets, such as the difference in diameter between tiny Mercury (4878 km) and mighty Jupiter (14,300 km). To return to the list of planets, press RETURN.

Figure 2
Planet Symbols

PLANET	SYMBOL	PLANET	SYMBOL
Mercury	☿	Jupiter	♃
Venus	♀	Saturn	♄
Earth	⊕	Uranus	♅
Mars	♂	Neptune	♆
		Pluto	♇

Menu Item 2: Relative Sizes

This option will assist you in visualizing planetary size. Here, the program asks if you wish to view one planet, two for comparison, or all. The indicated planet(s) will then be drawn on the screen, again with their universal symbols (see Figure 2).

Menu Item 3: Relative Orbits

The information in this section illustrates the position of the planets in relation to each other. Here, there is a choice of viewing all nine planets, the inner four, or outer five. Viewing the planetary orbits by inner four or outer five at a time gives an improved scale while viewing all nine at once gives some indication of the tremendous distances involved. After requesting one of these options, the program will draw the orbits of the planets as seen from an oblique angle. This angle is necessary to give maximum view since the planets' orbital sizes vary so greatly. Also, the great eccentricity of Pluto's orbit actually causes it to cross that of Neptune.

Sub-section #4 of Relative Orbits is provided to give an understanding of the various orbital speeds of the planets. After selecting this option, you will key in a time increment (the amount of time between each positioning of the planets). The screen will then show the sun and the planets below it in order of closeness to the sun. The scale is not true, but spaced so that you can more easily place each planet. The planets will begin to move and, with each movement, the number of elapsed increments (week-month-year-decade) will be displayed. For true planet postions, see option #5 on the Main Menu or refer to Table 1 which lists both distance from the sun and orbital period of each planet.

Menu Item 4: Other Solar System Members

This section offers information on the sun and the moon, satellites of the planets, asteroids and interplanetary dust, and comets. The options are available by indicated number; further directions are given on the program as you proceed.

The sun-moon section provides text on both of these bodies, also a graphic demonstration of the phases of the moon.

The satellites sub-section lists the planets; you press the number of the planet to see information about its satellites or moons. Statistical material about them will appear on the screen, one satellite at a time, beginning with the one nearest the planet. As directed by the program, press any key to go from one satellite to the next. This material will help you appreciate how much the satellites vary. For instance, Saturn and Jupiter both have moons that are larger than the planet Mercury, yet some moons are smaller than many asteroids. When the list is complete, pressing any key returns you to the Other Solar System Members Menu.

Descriptive information about asteroids and interplanetary dust is available in that sub-section.

The comet sub-section offers graphic displays of a comet itself and the path a comet takes when entering the solar system, as well as textual information. The program indicates which keys to press for each option.

TABLE 1
PLANET ORBITAL DATA

	DISTANCE FROM SUN		SIDEREAL PERIOD	
PLANET	AU	10^6 KM	YEARS	DAYS
Mercury	0.3871	57.9	0.24085	87.97
Venus	0.7233	108.1	0.61521	224.70
Earth	1.0000	149.5	1.000039	365.26
Mars	1.5237	227.8	1.88089	686.98
Jupiter	5.2028	778	11.86223	
Saturn	9.5388	1426	29.4577	
Uranus	19.182	2868	84.013	
Neptune	30.058	4494	164.793	
Pluto	39.439	5896	247.686	

For the mean equator and equinox of 1960. Source: Supplement to *The American Ephemeris and Nautical Almanac.*

Menu Item 5: Planet Position

This section offers several ways of viewing the planets in relation to each other. Choosing the inner four, outer five, or all planets, the program can draw either a representation of the planets as they orbit the sun, or the planets as they are seen in the night sky within the constellations of the ecliptic (see section IV). The orbit option shows relative orbit position at a specified date to aid in spatial orientation of planetary position for that date. (You also key in a time increment and a choice between a stationary or dynamic view.) The constellation option allows you to display the night sky with planets shown in their correct position for the specified date. Press the space bar to see a table of right ascension and declination for the indicated planets. These values will help you locate the planets in the sky using a telescope.

Under the constellation option, the selection of #1, Information, will provide a list of all the planets' locations within constellations as of your specified date. If you select a constellation number, you will see a graphical representation of the constellation and the planets within it. Note that only the constellations of the zodiac are listed because the planets only appear within the belt of the zodiac (the ecliptic). The planets maintain their positions in the constellation as it appears to move across the sky during the night.

A demonstration of retrograde motion is included in section 5. Retrograde motion is an apparent phenomenon occuring when the Earth, which is moving faster around the sun than the *outer* planets appears to stop its regular eastward motion through the sky and go backward for a time. (For a more detailed explanation, see section IV, 3.)

The program presents a model of retrograde motion by placing the sun in the Earth's orbit. As you view the planets in motion, then, it is as though they are orbiting the Earth. You observe all of the outer planets' retrograde

motion as it would appear from this central position. As the planet's position changes by the time increment you specify, the model will cause the planet to move in a curly-cue during the time period that retrograde motion is occurring. The ture appearance of retrograde motion in the sky, however, corresponds more closely to the diagram presented in Section IV, 3.

Menu Item 6: Terminate

To terminate the program, enter #6 from the Main Menu. You will then be asked to verify your choice with a Y or N. The program should always be terminated this way, instead of by simply removing the disk from the drive at an arbitrary point in the program. Proper termination returns the computer's operating system back to normal, removing the special conditions placed into it by the program.

SECTION IV
ADDITIONAL SOLAR SYSTEM INFORMATION

The Ecliptic

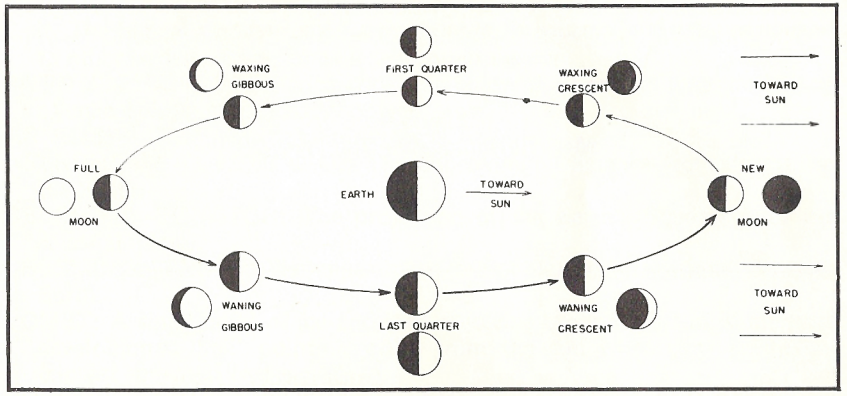
The Earth and the other planets revolve around the sun within 8 degrees of the same plane; the moon revolves around Earth in this plane also. Twelve constellations define this plane and are collectively referred to as the zodiac. Looking at the sun from Earth, it appears to be in a given constellation in this plane also. As the Earth rotates around the sun, the sun appears in each constellation in turn during the year. The projection of the orbital plane onto the celestial sphere is called the ecliptic, and is so named because all lunar and solar eclipses occur when the moon is on or near it.

The twelve constellations of the zodiac are arranged successively along the ecliptic. Of the twelve, seven were said to represent animals, and the Greeks called the zone "zodiakos kyklos" (circle of animals). In astrology, the signs of the zodiac were given mystical significance, but for astronomical study the constellations are used only as convenient areas of reference. All of the planets of our solar system can *always* be found in one of the 12 constellations of the ecliptic, except Pluto whose extreme eccentricity occasionally takes it out of this zone.

Phases Of The Moon

As the moon revolves around the Earth, we see larger or smaller portions of its sunlit hemisphere depending on the relative positions of the Earth, moon, and sun, as illustrated in Figure 3. For example, when they are positioned in a straight line with the moon on the opposite side of the Earth from the sun, we see all of the sunlit hemisphere — what we call the Full Moon. We refer to this view of the moon, and the other partial views, as phases of the moon.

Figure 3
Phases of the Moon



Beginning at the time the moon is between the sun and the Earth, its entire darkened hemisphere is turned to us, making it invisible. This phase is the New Moon. Most of the time the moon passes slightly above or below the sun, since the plane of its orbit is at a slightly higher angle than is Earth's around the sun, but occasionally it goes in front of the sun creating a partial or total solar eclipse. Eclipses of the sun only occur during the New Moon.

As the moon moves on around the Earth we can begin to see parts of the sunlit hemisphere. A few days after the New Moon, a narrow section of the Moon is visible — this is the Waxing Crescent. After seven days, the Moon has achieved one quarter of its revolution around the Earth. It is then in its First Quarter phase, and from Earth we see it as a semi-circle.

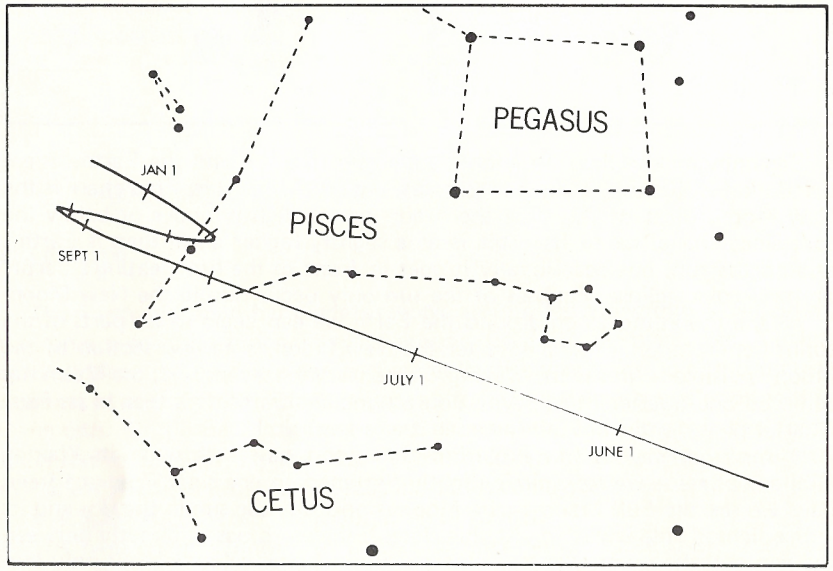
Almost halfway in its revolution the moon passes through its Waxing Gibbous phase — we see a circle slightly flattened on one side. Then at fifteen days we see the Full Moon — the Moon is opposite the sun in the sky and its entire lighted side is visible. At this time, if the earth passes directly between the sun and the moon, we see a lunar eclipse. Lunar eclipses occur only during the Full Moon.

The moon then proceeds through its Waning Gibbous phase during which we see almost a full circle as in the Waxing Gibbous, to its Last Quarter phase at twenty-two days during which we again see a semi-circle. It then passes through the Waning Crescent phase — the last few days of its revolution around the Earth — until it is again directly between the sun and the Earth and again a New Moon.

Retrograde Motion

As we view the planets from Earth, we observe that over a period of days or weeks, they travel eastward relative to the stars in what is called direct motion. But at certain intervals the outer planets (those farther from the sun than Earth) appear to stop and move backward for a time — in retrograde motion. Later they resume their direct motion, creating an apparent zigzag path across the sky. Figure 4 illustrates this phenomenon with the apparent motion of Mars against the stars in 1973.

Figure 4
Mars Retrograde Motion (1973)



Retrograde motion occurs when the Earth, which is moving faster around the sun than the outer planets, overtakes and passes one of them. As the Earth passes, the outer planet is in opposition, that is, it is in a straight line with the Earth and Sun, with the outer planet and sun on opposite sides of the Earth. Against the backdrop of distant stars, the outer planet appears to stop and move westward, or backward, during this period of opposition. As the Earth moves on around the sun and out of opposition with the outer planet, the outer planet appears to resume its eastward motion across the sky.

The same apparent phenomenon occurs as you overtake another car traveling in the same direction on the highway. As you approach it, the other car moves in the same direction as your car against the landscape. As you pass it, it appears to be moving backwards in relation to the more distant landscape. If you look back after you have passed, the other car again appears to move forward.

GLOSSARY OF ASTRONOMICAL TERMS

ALBEDO: The fraction of light which a body reflects of that which falls on it. The higher a body's albedo, the brighter it appears in the sky compared to other bodies of the same distance from the sun.

ALTITUDE: Angular distance above or below the horizon, measured along a vertical circle, to a celestial object.

ASTEROID: Synonym for minor planet.

ASTRONOMICAL UNIT (AU): The approximate distance from the sun to the Earth.

CELESTIAL EQUATOR: The projection of the Earth's Equator onto the celestial sphere.

CELESTIAL SPHERE: The apparent sphere of sky and stars that surrounds Earth.

COMET: A small body of ice and dust revolving around the sun, sometimes developing a 'tail' pointing away from the sun when near perihelion (closest approach to the sun).

CONSTELLATION: A configuration of stars in a certain limited region of the sky, regardless of their distance from Earth.

CRATER: A more or less circular depression on the moon or other solar system member caused by volcanic activity or meteor impact.

DECLINATION: One of a system of coordinates, along with right ascension, that is measured on the celestial sphere instead of on Earth, as latitude and longitude. The position of a star or other point is measured on an hour circle north or south of the celestial equator.

ECCENTRICITY: The degree to which the orbit of a revolving body is oval, or elliptical, instead of round.

ECLIPTIC: The area in the sky where constellations of the zodiac, planets, the sun and moon are observed, since the orbital planes of the moon around the Earth, and other planets around the sun, etc. roughly correspond. (See explanation in Section IV, Other Solar System Information.)

EQUATIONAL INCLINATION: The tilt of a rotating body's equator as compared to its orbital plane.

EQUINOX: One of the intersections of the ecliptic and celestial equator. The two equinoxes are the vernal equinox (the advent of spring) and the autumnal equinox (the beginning of fall).

ESCAPE VELOCITY: The velocity needed to escape the gravitational pull of a body.

ESTRASOLAR: Outside of the sun.

HORIZON: An extension onto the celestial sphere of the Earth's horizon.

INCLINATION OF ORBIT: The difference in angle of orbits between a revolving planet or body and the ecliptic.

INTERPLANETARY MEDIUM: The sparse distribution of gas and solid particles in the interplanetary space.

KELVIN: The temperature scale most often used in astronomy. It measures temperature from absolute zero (-273 degrees C.=0 degrees K.), the point at which all molecular activity stops.

LIGHT YEAR: The distance light travels in one year or roughly 5.88*10e12 miles or 5,880,000,000,000 miles.

MAGNITUDE: A measure of the amount of light received from a star or other luminous object – its relative brightness.

MASS: A measure of the total amount of material in a body; defined either by the inertial properties of the body or by its gravitational influence on other bodies.

MEAN DENSITY: The ratio of an object's mass to its volume. A density less than one will float in water while greater than one will sink.

METEOR: The luminous phenomenon observed when a meteroid enters the Earth's atmosphere and burns up.

METEORITE: A portion of a meteoroid that survives passage through the atmosphere and strikes the ground.

METEOROID: A stony or metallic particle in space before any encounter with the Earth.

MINOR PLANET: Synonym for asteroid. One of several tens of thousands of small planets, ranging in size from a few hundred kilometers to less than one kilometer in diameter. Most minor planets in our solar system orbit between Mars and Jupiter.

OBLATENESS: The amount of flattening that occurs at the poles of a rotating body.

PERIOD OF ROTATION: The time required for one complete rotation. On earth, this is one day.

PLANET: Any of the nine largest solid bodies revolving about the sun.

RETROGRADE MOTION: An apparent westward motion of a planet on the celestial sphere or with respect to the stars. (See Section IV, Other Solar System Information.)

RIGHT ASCENSION: One of a system of coordinates, along with declination, that is measured on the celestial sphere instead of on the Earth, as latitude and longitude. Right ascension is the position of a star or other point measured eastward to the hour circle of the star from a reference point (the vernal equinox) on the celestial equator.

SATELLITE: A body that revolves about a larger one; for example, a moon of a planet.

SEMIMAJOR AXIS: In an elliptical orbit, the distance from the center of the ellipse out to one end of the orbit.

SIDEREAL PERIOD: The period of revolution of one body about another; in our solar system, the time required for a planet to make one revolution of the sun.

SOLAR SYSTEM: The system of the sun and the planets, their satellites, the minor planets, comets,meteoroids, and other objects revolving around the sun.

SOLAR WIND: Charged particles ejected from the sun and flowing outward in gusts throughout the entire solar system, traveling at speeds between 200 and 400 miles per second.

SPECIFIC GRAVITY: The ratio of the density of a body or substance to that of water.

SYNODIC PERIOD: For planets, this is the interval in which the Earth gains a lap on one of the outer planets; or in which Mercury or Venus gains a lap on Earth.

TROPICAL YEAR: Period of revolution of a body about the sun with respect to a fixed location in space (vernal equinox).

VELOCITY OF ESCAPE: The speed with which an object must move in order to enter a parabolic orbit about another body, and hence move permanently away from the vicinity of that body.

VISUAL MAGNITUDE: A measure of the amount of visible light received from a star or other luminous or reflecting body.

ZENITH: The point exactly overhead in a line extended upward from Earth to the celestial sphere. At the Earth's North Pole, an observer would see the north celestial pole directly overhead (at zenith).

ZODIAC: A belt around the sky centered on the ecliptic within which the 12 constellations are found. The sun and the planets, with the exception of Pluto, are always seen within it.

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Requires Apple II with Applesoft in ROM,
48K RAM, and 1 disk drive.

Synergistic
Software

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