THE SOLAR SYSTEM DATABASE

USER'S HANDBOOK

KW
KNOW WARE

THE

SOLAR SYSTEM DATABASE

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OVERVIEW

The Solar System Database is a two disk package on the solar system, astronomy, space exploration and manned flight.

Disk one consists of files on:

* the Milky Way
* the members of the solar system
* the history of astronomy
* space exploration
* astronomical terms

The files can be searched using a Word Search facility, then viewed and printed in part or in whole.

Disk two consists of two databases, a field formatting utility, a histogram graphing utility and computer graphics. The databases include data on

* the planets and their satellites
* space exploration and manned flight

The computer graphics section includes both still slides and motion sequences. All displays are appropriately labelled and explained.

The package is supported by a Users' Manual which includes worksheets, activity sheets and information/display sheets.

The Solar System database is a closed database intended for use in upper primary and secondary schools. It can be used by individual students or small groups or as a research tool by teachers. It is designed to

* encourage problem solving using a database
* develop analytical, interpretative and research skills
* give the student practical experience in using different database formats
* give the student information in a way which fosters written expression skills
* encourage students to gather additional information from other sources
* give the user control of the package and content
* allow for simple as well as complex use
* be as attractive and complete as the computer hardware will permit

The worksheets and activity sheets vary in their level of difficulty. They are designed for use with the package, to demonstrate its power and scope, to encourage problem solving and to guide those teachers who wish to design their own material.

GETTING STARTED

This package will run on an Apple II+, IIe or IIc microcomputer with 48K of RAM, one disk drive and monitor (Apple is a trademark of Apple Computer, Inc.). For best screen clarity, we suggest that a colour monitor be switched to monochrome.

Insert the required disk in the disk drive and then turn on the computer. The system will boot to a Main Menu with 5 areas from which to select. It is not necessary to turn the computer off to use the other disk.

A serial or parallel printer attached to **slot 1** may be used to obtain a printout of any file or data. Provision has been allowed for the printing of screen graphics provided your printer has graphics printing capabilities and provided it is configured using the Printer Configuration option on Disk 2 (see Addendum B for more details).

Each of the disks must be used separately. The program will prompt you to change disks when necessary.

DISK ERRORS

Should a disk drive fail to "boot" a disk or fail to read a file or program on it, the computer will end execution of the program and report an Error 8 which signifies an Input/Output error.

Such an error will occur if

* the disk is not properly inserted in the disk drive,
* the disk drive is faulty, or if
* the disk has been damaged.

To eliminate the first possibility, just remove the disk, turn off your computer and then start-up again. If an error still occurs at the same point, the problem is either a faulty drive or a damaged disk.

A disk drive with an out-of-alignment read/write head or a too fast/too slow rotation speed may cause problems. If you have problems with more than one disk in this package or with other commercial software, it is almost certain that your disk drive is faulty.

Of course disks can be damaged. A scratch, fingerprint or exposure to heat or magnetic sources can cause errors. If you suspect you have a faulty disk, send it to us for replacement.

GENERAL COMMANDS

The following commands are used in the package:

COMMANDS TO USE THE FLY-AROUND (Selection Box)

-->	to move the selection box forward.
<--	to move the selection box backward.
/	to move to the next page.
SPACEBAR	to move to the other column.
RETURN	to confirm the category inside the selection box.
ESC	to return to the previous level or menu.

the down arrow and up arrow keys on the IIe and IIc correspond to the --> and <-- keys respectively.

COMMANDS TO USE IN VIEW FILE

--> or F	to move a PAGE FORWARD.
<-- or B	to move a PAGE BACK.
U	to move a LINE UP.
D	to move a LINE DOWN.
T	to move to TOP of file.
E	to move to END of file.
P	to print the file.
S	to enter the WORD SEARCH utility.
SPACEBAR	to look for another search match.
M	to mark a text block and print.
H	for the Help screen.
ESC	to exit.

the down arrow and up arrow keys on the IIe and IIc correspond to the U and D keys respectively.

RESERVED WORDS FOR THE WORD SEARCH UTILITY

AND OR AFTER BEFORE FROM TO

COMMANDS FOR SCREEN GRAPHICS

P	to print a screen graphics page.
ESC	to exit.

DISK 1

FILES

VIEW FILE

WORD SEARCH

DISK 1 CONTENTS

Disk 1 contains twenty-four files on the solar system, astronomy and space exploration. These files provide additional information that could not be readily included in a database environment. Two utilities, **VIEW FILE** and **WORD SEARCH,** are provided for viewing and/or searching the files.

Two of the files contain chronological information on the history of astronomy and on space exploration. Their content is organised in point form by year up to 1986. Their titles are:

* History
* Space Exploration

The remaining files are generally in narrative form. Most contain a facts and figures section at the end of the file. One of the files is a dictionary of astronomical terms and their meanings. The file titles are:

* Astronomers
* Dictionary
* Space Shuttle
* Asteroids
* Comets
* Magnetosphere
* Meteoroids
* Milky Way
* Planets
* Stars
* Solar System
* Sun
* Moon
* Mercury
* Venus
* Earth
* Mars
* Jupiter
* Saturn
* Uranus
* Neptune
* Pluto

All the files in the second column include extensive facts and figures under the headings, Physical Data and Orbital Data.

On choosing the **FILES** category from the Main Menu, the computer will ask the user to select either **VIEW FILE** or **WORD SEARCH**. The **FLY-AROUND** must be used for this purpose. The **VIEW FILE** utility is described on page 13 and the **WORD SEARCH** utility on page 15.

THE FLY-AROUND SELECTION SYSTEM

The Solar System package uses a moveable selection box to reduce keyboard entry and to simplify control of the package by the user.

The moveable selection box highlights the item currently recognised by the computer. The **arrow and other keys** may be used to move the box to another item. Once the desired item is highlighted, it can be selected by pressing the **RETURN** key. A bell will sound if a wrong key is pressed. See page 5 for a summary of commands.

DISK 1
MAIN MENU

The **MAIN MENU** lists the various categories of information in the Solar System package.

FILES	(PRESS 1)	The files contain information on the members of the solar system, other celestial bodies, the history of astronomy and space exploration. See Page 9.
SLIDES	(PRESS 2)	Computer graphics are used to display prepared slides on eclipses, orbits, tides, axial tilts, etc. If selected from DISK 1, you will be asked to change disks. See Page 34.
EXPLORATION DATABASE	(PRESS 3)	The (Space) Exploration Database contains details on manned flight and on the exploration of the solar system by space probes. If selected from DISK 1, you will be asked to change disks. See Page 25.
SOLAR SYSTEM DATABASE	(PRESS 4)	The Solar System Database contains details on the planets and their natural satellites. If selected from DISK 1, you will be asked to change disks. See Page 25.
PRINTER	(PRESS 5)	A Printer Configuration utility is available on DISK 2 for the printing of histogram graphs or slides. If selected from DISK 1, you will be asked to change disks. See Page 34.

VIEW FILE

The **VIEW FILE** utility may be used with any of the files. Basically, it allows the user access to an individual file to read, print or search. On selecting this utility, a list of file names will be displayed from which to select. Use the **FLY-AROUND** to select the file required.

CONTROL OF FILE DISPLAY

On entering a file, the computer will display its name and the first page of text. The text can be moved up or down a line or page at a time. If a command is given to move beyond the file limits, the computer will display either **END OF FILE** or **TOP OF FILE.**

To move by page, use the **FORWARD ARROW** or **F** key for **PAGE FORWARD** and the **BACK ARROW** or **B** key for **PAGE BACK.**

To move by line, use the **UP ARROW** (IIe or IIc) or **U** key to move a **LINE UP** and the **DOWN ARROW** (IIe or IIc) or **D** key for **LINE DOWN.**

The **T** key returns display to the **TOP OF FILE** and the **E** key to the **END OF FILE.**

PRINTING OPTIONS

The whole file or part(s) of it can be sent to an online printer at any time during display. It is assumed that a connected printer is attached to **slot 1.**

Press the **P** key to print the entire file or the **M** key to mark and print part of the file.

The **MARK AND PRINT** routine allows the user to print a line, lines or paragraph without printing the entire file. The file name will also be printed, but only once if more than one part of the file is printed.

Press the **M** key to turn on the marker. A flashing cursor will appear on the left margin. Move the cursor to the first line to be printed using the **U** key or **UP ARROW** to move the cursor up or the **D** key or **DOWN ARROW** to move the cursor down. The other movement keys may also be used.

Press the **M** key again to mark the first line. If more than one line is to be printed, move the cursor (a second cursor will appear) to the last line to be printed.

Press the **M** key again and the text between and including the marked lines will be printed.

NOTES: A single line may be printed by moving the cursor to that line and pressing the **M** key twice.

Text is always printed from top to bottom. The first and last line positions will be reversed automatically by the computer if the cursor is moved above the first line marked.

WORD SEARCH IN VIEW FILE

At any time during the display of a file, the **WORD SEARCH** utility may be used by pressing the **S** key. The computer will request the search word or words and on pressing the **RETURN** key will search the file **from the current position towards the end of the file.** A successful match will be highlighted. An unsuccessful match will cause a message, **SEARCH: NOT FOUND**, to be displayed at the bottom of the screen.

If further occurrences of the word(s) are required, it is not necessary to re-enter the search request. On pressing the **SPACEBAR**, the computer will again scan **from the current match position towards the end of the file.** Any further matches will be highlighted.

For further information on **WORD SEARCH**, please refer to page 15.

HELP

A summary of commands available for use when viewing a file may be accessed by pressing the **H** key. Use the **RETURN** key to exit back to the file.

WRONG KEY

The pressing of a wrong key will cause a message, **TYPE H FOR HELP**, to be displayed. This message may be cancelled by pressing any valid key or by displaying the Help Screen.

SUMMARY OF COMMANDS

--> or F	to move a PAGE FORWARD.
<-- or B	to move a PAGE BACK.
U	to move a LINE UP.
D	to move a LINE DOWN.
T	to move to TOP of file.
E	to move to END of file.
P	to print a file.
S	to enter the WORD SEARCH utility.
SPACEBAR	to look for another search match.
H	for the Help Screen.
M	to Mark and Print.
ESC	to exit

the up arrow and down arrow on the IIe and IIc may be used to move a line up or a line down respectively.

WORD SEARCH

The **WORD SEARCH** utility may be used on any one or on all of the files. Basically, it allows the user to search a file or all files for a word, part of a word or a combination of words. In addition, the user may set time boundaries for the files, **History** and **Space Exploration** (for example **BEFORE 1980** or **FROM 1970 TO 1986**). On selecting this utility, a list of file names will be displayed from which to select. Use the **FLY-AROUND** to select the required file.

TYPES OF REQUESTS

Before describing the rules to follow when entering a request, it would be wise to describe what **WORD SEARCH** can and cannot do.

As previously mentioned, the **WORD SEARCH** utility provides a means of searching a file or all files for a word, part of a word, a phrase or a combination of these. In addition, time parameters can be set for the files, History and Space Exploration.

The simplest use of **WORD SEARCH** is in searching for a single item. For example:

PHOEBE
GALILEO
1970
RETROGRADE
CARBON DIOXIDE

A complex search may involve searching for two items using an **AND** or an **OR** connector. For example:

MARINER OR VOYAGER
HYDROGEN AND HELIUM
1985 AND 1986

With an **OR** connector, **WORD SEARCH** looks for both words and will report a match if one or both are found in a file.

With the **AND** connector, **WORD SEARCH** also looks for both words and will only report a match if both occur in the same file. In the second example, both **HYDROGEN** and **HELIUM** must be mentioned in the same file if a match is to be found.

A more complex search can involve up to three items connected by **AND**s or **OR**s. Precedence for searching is from **LEFT to RIGHT**. Examples might be:

VOYAGER 1 OR VOYAGER 2 AND JUPITER
DISCOVERED AND RINGS AND SATURN

In the first example, the computer would search for references to Voyager 1 or Voyager 2 as a first search, and then, if a match is found, for Jupiter. The request would thus be seen as: (Voyager 1 or Voyager 2) and Jupiter.

In the second example, the computer would report those files containing the words, discovered, rings and Saturn. Precedence is still from left to right, but in this case it is not relevant as only one type of connector (**AND**) is used.

The power of the **WORD SEARCH** utility extends to time. Using the reserved words **BEFORE, AFTER** or **FROM TO,** time periods can be set for searching the files, **History** and **Space Exploration.** Examples might be:

SATURN BEFORE 1700
MOON FROM 1965 TO 1970
MOON AND USA FROM 1960 TO 1986

Because of memory limitations, the **Word Search** utility does not allow for character matching within words or for the use of brackets to establish precedence. It will also treat as **BAD INPUT** the improper use of reserved words.

Special characters will not be accepted. A bell will sound if an invalid key is pressed.

DIRECT ENTRY

The direct entry mode allows the user to enter his/her search request including connectors. It is the fastest method for entering a request. Upper and/or lower case characters may be used.

When entering the Search Phrase, it must be noted that some words are reserved words and therefore cannot be used for searching. They are **AND, OR, BEFORE, AFTER, FROM** and **TO**. A space preceeding any of these reserved words is all that is necessary to invoke them.

As the commands **BEFORE, AFTER** and **FROM TO** are only available for use with the files, History and Space Exploration, a message will be displayed at the bottom of the screen indicating whether they can be used or not to search the files selected. It should be noted that they cannot be used if "ALL" is selected.

The length of the **search request** including reserved words has been set at 60 characters.

RESERVED WORDS

And
Or
Before
After
From, To

SEARCHING FILES

Having entered the search request, the computer will check the validity of the request and then commence searching the file or files. If an error is detected in the request, for example, no year set for a time period command, the computer will display **BAD INPUT** and sound a bell.

If **ALL** files in a category are to be searched, the user will be kept informed of how many files have been searched and the number of matches found. The **ESC** key may be used to exit at any time. All matches up to that point can be inspected.

After the search is completed and the **RETURN** key pressed, the names of all the matching files will be displayed. Any of the files can be selected for viewing using the **FLY-AROUND**.

VIEW FILE AFTER WORD SEARCH

The **VIEW FILE** utility can be used to inspect or print a file (see page 13).

When moving from **WORD SEARCH** to **VIEW FILE,** the details of the search request are carried across. The computer will proceed to the page of text containing the first occurrence of any part of the matching request and highlight the match. The **SPACEBAR** may be used to proceed to the next match if any. The movement commands can be used to proceed through the text (see page 14).

It is important to note that although the word search utility may be used from within **VIEW FILE**, its use will **NOT CANCEL** the original search request. Therefore, the user can do new searches within a file, exit that file, and enter another file in the match list without losing the first word search request.

HIGHLIGHTING

In many situations, particularly those involving complex requests, the matching words may be on different pages of text. In such situations, it is necessary to scroll through the text to find the case of highlighted text.

As mentioned previously, only the first complete incidence of a successful match will be highlighted. If it is suspected that more than one incidence may occur in the file, use the **SPACEBAR** to search for the next match. If one is there, it will be highlighted. If not, the message, **SEARCH: NOT FOUND**, will be displayed.

With regards to the **OR** connector, the computer will highlight all successful matches in the search request. If a time period has been set, only matches within that period will match and therefore be highlighted.

DISK 2

SLIDES

EXPLORATION DATABASE

SOLAR SYSTEM DATABASE

PRINTER

DISK 2 CONTENTS

Disk 2 contains a range of slide graphics and two databases, one on **Space Exploration** including manned flight, and the other on the **Solar System**'s planets and satellites.

The (Space) **Exploration Database** contains data on the journeys of space probes and manned flights. There are 253 records each with 8 fields:

* Spacecraft, Year of Launch, Country, Destination, Purpose, Crew, Fatalities, Result

The **Solar System Database** contains historical, physical and orbital data on the planets and their natural satellites. There are 69 records each with 20 fields:

* Name, Type, Central Body, Position to Central Body, Size to Central Body, Magnetic Field, Atmosphere, Rings, Satellites, Orbit, Discoverer, Year Discovered, Diameter, Distance, Orbital Period, Orbital Velocity, Density, Surface Gravity, Eccentricity, Inclination

The information in the databases can be accessed using three search options, of which two provide for the total analysis of the contents of any field. Simple or complex searches can be requested.

A **FORMAT** utility may be used on the results of a database analysis to sort and print the data from up to 5 fields in the matching records.

A **HISTOGRAM** graphing utility may be used to draw Histogram charts of the results of any database analysis where the total contents of a field have been analysed. It may also be used to graph comparative values for the Sun's planets and each planet's satellites.

Disk 2 also contains a **SLIDES** option which uses computer graphics to display still slides or motion sequences. All are displayed with labels and/or commentary.

With a parallel or Imagewriter printer, it is possible to obtain a printout of a slide or histogram graph. To use this utility, it is necessary to tell the computer what sort of printer is connected. A **PRINTER CONFIGURATION** routine is provided for this purpose.

THE FLY-AROUND SELECTION SYSTEM

The Solar System package uses a moveable selection box to reduce keyboard entry and to simplify control of the package by the user.

The moveable selection box highlights the item currently recognised by the computer. The **arrow and other keys** may be used to move the box to another item. Once the desired item is highlighted, it can be selected by pressing the **RETURN** key. A bell will sound if a wrong key is pressed. See Page 5 for a summary of commands.

DISK 2
MAIN MENU

The **MAIN MENU** lists the various categories of information in the Solar System package.

FILES	(PRESS 1)	The files contain information on the members of the solar system, other celestial bodies, the history of astronomy and space exploration. If selected from DISK 2, you will be asked to change disks. See Page 9.
SLIDES	(PRESS 2)	Computer graphics are used to display prepared slides on eclipses, orbits, tides, axial tilts, etc. See Page 33.
EXPLORATION DATABASE	(PRESS 3)	The (Space) Exploration Database contains details on manned flight and on the exploration of the solar system by space probes. See Page 25.
SOLAR SYSTEM DATABASE	(PRESS 4)	The Solar System Database contains details on the planets and their natural satellites. See Page 25.
PRINTER	(PRESS 5)	A Printer Configuration utility is available on this disk for the printing of histogram graphs or slides. See Page 34.

THE DATABASES

There are two databases in this package. The Space Exploration Database consists of categorised information on 253 flights by space probes and man. The Solar System Database consists of historical, physical and orbital data on the Solar System's planets and their natural satellites. There are 69 records in this database. Further details on the structure of the databases, the fields and their content are provided in Addendum A.

There are three search options available for use with the databases.

OPTION 1 may be used to select a single field for the total analysis of all items within that field. For example, the field, Country (in the Space Exploration Database), could be searched to find the number of launches by the USA and the USSR. Further details on this option are on Page 26.

OPTION 2 may be used to select up to 4 fields, to determine one field item for each field and then, if more than 1 field has been selected, to construct a search formula with ANDs and/or ORs and brackets. For example, the Solar System Database could be searched to find out which planets have rings (ie Type = Planet AND Rings = Present). Further details on this option start on Page 26.

OPTION 3 may be used to select a single field for Total Analysis and include in the search, a field item from a single field or a formula made up of field items from up to 4 fields. It combines the powers of options 1 and 2. An example of its use might be to totally analyse the field, Country (in the Space Exploration database) and find out which country has made manned flights to the Moon and how many. The Total Analysis field would be Country and the other fields, Destination and Crew (ie Destination = Moon and Crew > 0). Further details on this option start on Page 29.

When using the database, the results of any analysis or the content of any record can be sent to an online printer by pressing the **P** key.

There is a **Histogram** graphing utility available for use with options 1 and 3. This utility may be entered after a successful analysis has been completed. The use of this utility and its limitations are detailed from Page 33.

SPECIAL NOTE: On selecting an option, the database program and data file will be loaded and a **FIELDS MENU** displayed. The **ESC** key may be used at this menu to exit out of the database and go back to the **MAIN MENU**.

When assembling a Search Formula in options 2 or 3, the **ESC** key may be used to delete the last operation and therefore backtrack one step. Thus field items and operators may be changed by using the **ESC** to backtrack and then entering a new "value".

OPTION 1

SEARCH - ONE FIELD: TOTAL ANALYSIS

On selecting Option 1, a Fields Menu will be displayed from which to select a field for total analysis, that is, by all possible field items in that field. Only one field can be selected for analysis. Use the **FLY-AROUND** to make the selection.

A search will proceed through the entire database, unless stopped by pressing the **ESC** key. At the conclusion of the search, a list of field items for the selected field will be displayed together with the number of matches found for each item.

In the case of an analysis on a "year" field, such as Year Discovered (in the Solar System Database), only those years for which a match was found will be displayed. In this way, the length of the display has been reduced.

OPTION 2

SEARCH - ALL FIELDS: SIMPLE ANALYSIS

The Simple Analysis option has been so named because only one field item per field is subject to analysis. For example, if the field Destination (in the Solar System Database) was selected, it would be necessary to select an **OPERATOR** such as = (equals) or <> (not equals), and one of the field's **field items** such as Venus. The search request thus becomes Destination = Venus.

With this option, up to four fields can be selected for analysis. If more than one field is selected, it will be necessary to form a search formula by connecting the fields with **AND**s or **OR**s and brackets. This is covered in more detail later on page 28.

On entering this option, a Fields Menu will be displayed. Use the **FLY-AROUND** to select a field. After each field is selected, a list of fields selected so far will be displayed together with a menu of commands at the bottom of the screen page.

The commands menu consists of three options: **NO MORE FIELDS**, **MORE FIELDS** and **DELETE A FIELD**. If 4 fields have been selected, the **MORE FIELDS** option will not be displayed. Use the **FLY-AROUND** to select the required option.

If the **DELETE A FIELD** option is requested and only one field has been previously selected, that field will be deleted and control returned to the Fields Menu. If more than one field has been selected, the number of the field to be deleted will need to be entered. The **ESC** key may be used to cancel the option and return to the Selected Fields display.

OPERATORS

Once the required fields have been selected, it is necessary to determine the search details for each field. Each field is dealt with in the order displayed on the screen.

For each field, it will be necessary to select an **OPERATOR** (eg. =, <>, etc.) and a **FIELD ITEM.** The appropriate operators for a field will be displayed at the bottom of the screen. Use the **FLY-AROUND** to select the desired operator. The **ESC** key may be used to go back one step if required.

The operators for alphabetic fields are:

=	equals
<>	not equals

The operators for numeric fields are:

<	less than
<=	less than or equals
=	equals
>	greater than
>=	greater than or equals
<>	not equals

FIELD ITEMS

After selecting an operator, the computer will display either a list of field items or request keyboard entry depending on the field chosen. For numeric fields such as Year of Launch, Crew, Diameter, Distance, etc., the computer will request the entry of numeric characters to form the value on which to search. In some cases, the size of the field is important as an error will be signalled if the number of characters entered is greater than the number permitted or in the case of a Year field, the number of characters is not equal to four. For example, if three or five characters (eg 18121, 182, etc.) are entered for a year, an error will be signalled. This restriction does not apply to fields such as Diameter, Distance, Orbital Period, etc., in the Solar System Database.

As each field is given an operator and a field item, the selections will be displayed on screen. If one field has been selected, the search will automatically begin after the field item has been selected or entered.

If more than one field item has been selected, it will be necessary to prepare a Search Formula.

The **ESC** key may be used at any stage to cancel the last process. It will not cancel everything selected so far.

SEARCH FORMULA

This section will be entered if more than one field has been selected for analysis.

The Search Formula is started by selecting two fields to form a Search Block and then connecting these fields together with an "**AND**" or "**OR**" operator. The computer will display a request, **SELECT FIRST FIELD,** at the bottom of the screen. Use the **FLY-AROUND** to select the field.

The computer will then display, **SELECT SECOND FIELD.** Use the **FLY-AROUND** to select the required field.

After the second field is selected, the **AND** and **OR** connectors will be displayed. Use the **FLY-AROUND** to select a connector. In this way a Search Block is formed. If only two fields have been selected for analysis, the computer will then search the database for matching information.

Further Search Blocks will need to be formed if more than 2 fields are to be linked. It is stressed that a Search Block can only have two fields. However, a previously constructed Search Block can be used as a "field" to form another Search Block.

As each field or Search Block is used, it is marked with an asterisk * to indicate it is no longer available for selection. Search Blocks will be labelled with an **A** for the First Block and a **B** for the Second Block.

Each Block will be automatically bracketed by the computer with the first field appearing to the left of the operator and the second to the right. Please note that the Search Formula is built from **left to right** and that bracketing stays with each block as it is constructed.

After the Search Formula has been determined, a message will appear asking whether the formula is correct. Use the selection box to select either **YES** or **NO**. A **NO** answer will cancel all choices and return control to the beginning of this section. The **ESC** key may be used to cancel the previous operation only.

Following is an example of how a Search Formula is constructed (assume 3 fields have been selected):

1 (field 1)
2 (field 2)
3 (field 3)

fields 1 and 3 are chosen with an "**OR**" connector. The screen and Search Block A would thus appear as:

*1 (field 1)
2 (field 2)
*3 (field 3)
A: (1 OR 3)

fields A and 2 are then chosen with an "**AND**" connector. The Search Formula becomes : A: ((1 OR 3) OR 2

OPTION 3

SEARCH - ALL FIELDS: TOTAL ANALYSIS

Option 3 combines the powers of option 1 (total analysis of a field) and option 2 (simple analysis using single field items). **Fields from 2 Field Menus** will need to be selected.

The First Field Menu displays the names of fields from which to select a field for total analysis, that is, by all field items in that field. Only one field may be selected for total analysis.

The Second Field Menu displays the names of those fields from which to select a field, an operator and a field item. Up to four fields each with one field item may be selected from the second menu. The selection of a field, operator, field item and the construction of a Search Formula is detailed from page 26 under option 2.

This search option will proceed through the entire database, unless stopped by pressing the **ESC** key. At the conclusion of the search, a list of field items for Total Analysis will be displayed together with the number of matches found for each item.

For details on the next steps in using this option, refer to the section, **MATCHING RECORDS**, on page 30.

SPECIAL CASE: In the Solar System Database, an analysis of any one of the fields Diameter, Distance, Orbital Period, Orbital Velocity, Density, Surface Gravity, Eccentricity or Inclination together with Central Body = Sun (or Jupiter, Mars, Neptune, Saturn, Uranus) will permit the histogram graphing of the **values** against the field items (planets or satellites). This is a valuable asset for comparing the characteristics of the planets or their satellites. See Page 33 for further details.

MATCHING RECORDS

On confirming the Search Formula, the computer will commence to search the database for records with matching data.

During the search, the number of matches found and the number of records searched will be displayed. The search may be stopped at any stage by pressing the **ESC** key. Only matched records up to that point will continue through the reporting process.

The results of the search will be displayed at the conclusion or termination of the analysis. For a **Total Analysis Search (options 1 and 3)**, the field items and the number of matching records for each will be displayed. For a **Simple Analysis (option 2)**, the names of the spacecraft (Space Exploration Database) or the names of the planets or satellites (Solar System Database) will be displayed.

The **RETURN** key should be used to read through the search results if all the data cannot be displayed on the one screen. The **ESC** key may be used to proceed to the Search Finished Menu.

SEARCH FINISHED MENU

Once the matching records have been found, a number of categories will be displayed from which to select what to do with the search results. The categories displayed depend on the search option chosen. For example, the Histogram Graphing Utility is only available for use on the data generated by option 1 or option 3. The Categories are:

SEE THE LIST AGAIN	the analysis results will be displayed again. See Matching Records above.
DISPLAY INDIVIDUAL RECORDS	each record may be viewed and printed using this category. See page 31.
ANOTHER SEARCH	control will return to the Fields Menu for another analysis.
CHANGE SEARCH OPTION	another search option may be selected through this category.
FORMAT	the format utility will be loaded for use on the matching records. See page 32.
RETURN TO MAIN MENU	control will return to the Main Menu.
GRAPH RESULTS	this category is available for search option 1 or 3. See Page 33.

Use the **FLY-AROUND** to select the desired option.

DISPLAY OF RECORDS

On entering this option, a list will be displayed from which to select a record(s) for viewing. The **ALL** option allows for every record to be viewed in turn according to the names displayed in the menu. If a single record is selected, then only that record will be displayed.

The **ALL** option offers the capacity to go through the records by pressing the **RETURN** key, and back towards the first record, by pressing the **<-- (back arrow)** key. The page of the record displayed is page 1 on first entering the routine and then the page last chosen thereafter.

In the Solar System database there are 2 pages of information available for each record in the database. Page 1 of each matching record will be automatically displayed on entering this mode for the first time. The other page of information can be displayed by keying in 2 (for page 2).

The **ESC** key may be used to exit to the records list or from there back to Search Finished Menu.

The display format is:

Field Names on the left.
the stored information (ie Field Item) for that field name on the right.
a blank space to indicate no data in a field.

FORMAT

The **FORMAT** utility may be used to extract specific information from the matched records. The information may be different to that used in the analysis of the database.

On entering this option, a **FIELDS MENU** will be displayed. Up to 6 fields may be selected for column printing or row printing. The number of fields which can be selected depends upon the accumulating size of the fields. The records will be **SORTED** by the contents of the **first field** selected.

After each field is selected, the fields selected so far will be displayed together with a menu of commands at the bottom of the screen. Use the **FLY-AROUND** to select either, **NO MORE FIELDS** or **MORE FIELDS** or press the **ESC** key to delete the last field chosen. The **MORE FIELDS** option will not be displayed if the accumulated size of the fields exceeds what can be displayed across the screen.

Once the desired fields have been selected, the computer will display the options **COLUMN PRINT** or **ROW PRINT**. Use the **FLY-AROUND** to select the required option.

The **COLUMN PRINT** option will print the fields in columns down the page. If the data cannot fit across the screen, the computer will shorten certain non-numeric fields until they fit. This shortening will not occur on data sent to a printer. Following is an example of Column Print:

NAME	YEAR DISCOVERED	DIAMETER	ATMOSPHERE
Adrastea	1979	25	None
Amalthea	1892	210	None
Ananke	1951	25	None

The **ROW PRINT** option will print the fields in rows across the page. Following is an example of Row Print:

NAME	Adrastea
YEAR DISCOVERED	1979
DIAMETER	25
ATMOSPHERE	None

Having selected the method of display, the computer will ask whether the information is to be sent to **SCREEN** or to a **PRINTER**. Use the **FLY-AROUND** to make the selection.

When displaying the data on screen, the computer will stop at the bottom of the page and wait for a key to be pressed before displaying the next page. On completion of the display, the following options will be offered:

LIST DATA	to change the output option.
ANOTHER ANALYSIS	to select new fields for formatting.
PRINT RESULTS	to send the data to a printer.
MAIN MENU	to exit and return to the Main Menu.
DATABASE	to exit and return to the database.

GRAPHS

A **Histogram Graphing** utility is available for use on data found with search options 1 or 3. The utility is chosen after an analysis has been completed.

The width of the histogram bars and the axis values are determined by the range of the data being graphed. In some cases, X-axis values are coded since in those situations, it is not possible to fit corresponding text. The codes and their meanings can be accessed by pressing the **RETURN** key. Press the key again to return to the graph.

This utility generally graphs the field item along the X-axis and the frequency of that item along the Y-axis. However, in the case of the Solar System database, the user may graph actual values for the planets or satellites along the Y-axis. For example, we can display the actual values of the field, Diameter, against the planets by using option 3 to select the field, Diameter, for Total Analysis and Central Body = Sun as the additional criteria. After analysis, the graphing utility can be used to graph the diameter values for the planets which are arranged in their order from the Sun.

Provided the Printer file has been configured for Graphics Printing, any graph and the accompanying codes can be sent to a printer by pressing the **P** key. See Addendum B if there are any problems in this regard.

On pressing the **ESC** key, a list of options will be displayed:

SEE GRAPH AGAIN	to return to the display.
PRINT RESULTS	to send the graph to a printer.
MAIN MENU	to exit and return to the Main Menu.
DATABASE	to exit and return to the database.

Use the **FLY-AROUND** to select the required option.

SLIDES

The **Slides** option makes use of computer graphics to display still slides and motion sequences on selected astronomical areas.

On selecting this option, a **TITLES MENU** will be displayed. The motion sequence slides are identified by a (**M**) after the title and the still slides by a (**S**). Use the **FLY-AROUND** to make a selection.

The motion sequence on eclipses uses a number of screens to describe and portray the Moon's orbit and then to show why and how eclipses occur. At prescribed points, the display will stop and wait for the **RETURN** key to be pressed before continuing. The **ESC** key may be used to exit back to the **TITLES MENU.**

Provided the Printer file has been configured for Graphics Printing, any screen display can be sent to a printer by pressing the **P** key. See Addendum B if there are any problems in this regard.

PRINTER CONFIGURATION

The **Printer Configuration** utility provides information on the commands available for outputing files or screen graphics to a printer. However, its primary function is to configure a printer for screen graphics printing. The disk is configured for an Imagewriter Printer and a Super Serial card at delivery.

If the printer being used is a parallel printer, then the code for outputing screen graphics can be entered using this utility. See Addendum B on Page 43 for a list of codes.

On selecting this utility, an options menu with some explanatory notes will be displayed. Use the **FLY-AROUND** to make a selection. If the **Parallel Printer** option is selected, the computer will request the entry of a control code. Remember to hold down the **CTRL** key while pressing the **I** key. Release both keys before entering the rest of the code. The **ESC** key may be used at any time to exit this utility.

The information contained in the configuration file can be changed at any time by reselecting the option from the **Main Menu.**

For further information on this utility, see Addendum B.

ADDENDUMS

ADDENDUM A

DATABASE FIELDS

The Space Exploration database is centred on the mission details of space probes and manned flights to 1986. The emphasis is entirely on those launches by the United States of America and the USSR. The National Aeronautics and Space Administration (NASA) reports to the Congress of America were the primary information source.

The Solar System database is centred on the the solar system's planets and their natural satellites. The data is the latest available and includes the discoveries made by Voyager 2 when it flew past Uranus in January 1986. As man's knowledge of the solar system is by no means complete, there are fields which contain no data (indicated by a blank). This is particularly the case for the satellites of the outer planets. It should be noted that while the figures on the characteristics of the planets and their satellites are up-to-date, some of these are disputed and will change as man's knowledge of the solar system increases.

The valid fields for the Space Exploration database are:

Spacecraft
Year of Launch
Country
Destination
Purpose
Crew
Fatalities
Result

The valid fields for the Solar System database are:

Name
Type
Central Body
Position to Central Body
Size to Central Body
Magnetic Field
Atmosphere
Rings
Satellites
Orbit
Discoverer
Year Discovered
Diameter
Distance
Orbital Period
Orbital Velocity
Density
Surface Gravity
Eccentricity
Inclination

FIELD ITEMS

SPACE EXPLORATION DATABASE

FIELD	FIELD ITEM		
Spacecraft	Apollo	Pioneer	Vega
	Cosmos	Pioneer Venus	Venera
	Explorer	Ranger	Viking
	Gemini	Salyut	Voskhod
	Luna	Shuttle	Vostok
	Lunar Orbiter	Skylab	Voyager
	Mariner	Soyuz	Zond
	Mars	Sputnik	Unknown-USSR
	Mercury	Surveyor	
Year of Launch	Numeric (Range: 1958 to 1986)		
Country	USA		
	USSR		
Destination	Earth		
	Halley's Comet		
	Jupiter		
	Jupiter Saturn		
	Jovian Planets		
	Mars		
	Moon		
	Venus		
	Venus Mercury		
Purpose	Circum		
	Fly-by		
	Impact		
	Land		
	Orbit		
	Orbit/Land		
	Sub-Orbital		
	Test		
Crew	Numeric (Range: 0 to 7)		
Fatalities	Numeric (Range: 0 to 7)		
Result	Failed		
	Partial		
	Success		

SOLAR SYSTEM DATABASE

FIELD	FIELD ITEM		
Name	Adrastea	Leda	Umbriel
	Amalthea	Lysithea	Uranus
	Ananke	Mars	Venus
	Ariel	Mercury	1980 S26
	Atlas	Metis	1980 S27
	Callisto	Mimas	1980 S34
	Calypso	Miranda	1981 S7
	Carme	Moon	1981 S8
	Charon	Neptune	1981 S9
	Deimos	Nereid	1981 S10
	Dione	Oberon	1981 S11
	Dione B	Pasiphae	1985 U1
	Earth	Phobos	1986 U1
	Elara	Phoebe	1986 U2
	Enceladus	Pluto	1986 U3
	Epimetheus	Rhea	1986 U4
	Europa	Saturn	1986 U5
	Ganymede	Sinope	1986 U6
	Himalia	Telesto	1986 U7
	Hyperion	Tethys	1986 U8
	Iapetus	Thebe	1986 U9
	Io	Titan	
	Janus	Titania	
	Jupiter	Triton	
Type	Planet		
	Satellite		
Central Body	Earth	Pluto	
	Jupiter	Saturn	
	Mars	Sun	
	Mercury	Uranus	
	Neptune	Venus	
Position to C.B.	Numeric (Range: 1 to 17)		
Size to C.B.	Numeric (Range: 1 to 17)		
Magnetic Field	Ionosphere		
	None		
	Present		
Atmosphere	Carbon Dioxide		Thin Helium
	Carbon Dioxide & N2 (Nitrogen)		Thin Methane
	Hydrogen & Helium		Thin Sulphur Dioxide
	Nitrogen & Methane		None
	Nitrogen & Oxygen		

Rings	Present No Rings	
Satellites	Numeric	(Range: 1 to 23)
Orbit	Direct Retrograde	
Discoverer	E. Barnard G. Cassini J. Christy Galileo J. Galle A. Hall W. Herschel C. Huygens C. Kowal	G. Kuiper W. Lassell P. Melotte S. Nicholson C. Perrine W. Pickering C. Tombaugh Voyager
Year Discovered	Numeric	(Range: 1610 to 1986)
Diameter	Numeric	(Range: 10 to 142,800 km)
Distance	Numeric	(Range: 9,380 to 5,900,000,000 km)
Orbital Period	Numeric	(Range: 0.29 to 90,472 days)
Orbital Velocity	Numeric	(Range: 4.74 to 47.89 km/sec)
Density	Numeric	(Range: 0.69 to 5.52 gm/cc)
Surface Gravity	Numeric	(Range: 0.40 to 22.88 m/sec/sec)
Eccentricity	Numeric	(Range: 0.000 to 0.750)
Inclination	Numeric	(Range: 0 to 163 degrees)

GENERAL COMMENTS

Material for the Solar System database package has been collected from a variety of sources.

It should be noted that in some instances these sources revealed conflicting information and also indicated that details were erroneously recorded. In such circumstances, we have used the latest and most accepted data.

We have endeavoured to ensure that the data contained in this package is accurate and up-to-date as at June 1986.

Following is information on the nature of the fields and the data contained in them.

SPACE EXPLORATION DATABASE

SPACECRAFT This field contains the series name of the spacecraft. For example, the Apollo series, the Mercury series, etc. When a record is displayed, the code number for the flight is added so that the spacecraft can be specifically identified.

YEAR OF LAUNCH The year in which the spacecraft was launched is recorded in this field. The exact date of launch is given at display.

COUNTRY The name of the country which launched the spacecraft is recorded in this field.

DESTINATION The major destination of the spacecraft is recorded in this field. The Jovian planets category comprises Jupiter, Saturn, Uranus and Neptune.

PURPOSE The nature of the flight is recorded in this field. The field item, Circum, means "circle and return". Sub-orbital refers to those craft which did not complete one orbit of the Earth.

CREW Unmanned flights are indicated by a 0 in this field. For manned flights, the range is from 1 to 7.

FATALITIES The number of fatalities for each flight are recorded in this field. As a 0 value is valid for unmanned flights, it is recommended that fatalities be analysed by searching manned flights only (eg Crew > 0).

RESULT Whether the flight achieved all or part or none of its objectives is recorded in this field.

SOLAR SYSTEM DATABASE

NAME The name of the planet or satellite is recorded in this field.

TYPE This field identifies the body as either a planet or satellite.

CENTRAL BODY The central body around which the planet or satellite orbits is recorded here. The central body may be the Sun or a planet.

POSITION TO C.B. The planet's or satellite's position out from the central body is recorded in this field. For example, the Earth is the 3rd planet from the Sun, its central body.

SIZE TO C.B. The ranking of the planet's or satellite's size to the other bodies orbiting the same central body is recorded in this field. For example, Jupiter is ranked 1 as it is the largest planet in the solar system. Earth is the 5th largest planet.

MAGNETIC FIELD A body can have a magnetic field induced internally or by the interaction of the solar wind with its atmosphere. Those bodies with magnetic fields induced by the solar wind are identified by the title, ionosphere.

ATMOSPHERE	Atmospheres can consist of many gases. For comparision purposes and brevity, we have categorised atmospheres by their major constituents only. For example, Nitrogen and Oxygen for Earth.
RINGS	Several planets have rings. This field applies to the planets only and records the presence or not of rings. No value is recorded in the records for the satellites. Such records are ignored during an analysis of this field.
SATELLITES	This field records the number of satellites orbiting a planet. No value is recorded in the records for the satellites. Such records are ignored during an analysis of this field.
ORBIT	All planets orbit the Sun in a counter-clockwise direction. Such orbits are called direct or prograde. Some satellites orbit their planets in a clockwise direction. Such orbits are called retrograde.
DISCOVERER	The inner and closest outer planets were well known to the ancients. However, astronomers and space probes have discovered new planets and satellites over the centuries. This field records the body's discoverer.
YEAR DISCOVERED	The year in which the body was discovered is recorded here.
DIAMETER	The diameter or in case of those irregularly shaped small satellites, the approximate diameter of the body is recorded in this field. Search requests may include a blank space to break up very big numbers (eg 142 800).
DISTANCE	The average distance of the body from its central body is recorded in this field. Search requests may include blank spaces to break up very big numbers (eg 778 300 000).
ORBITAL PERIOD	The period, in Earth days, that the body takes to orbit its central body is recorded in this field.
ORBITAL VELOCITY	The average orbital velocity of the body (in km/second) is recorded in this field.
DENSITY	The density of the body (in gm/cc) is recorded in this field.
SURFACE GRAVITY	The surface gravity of the body at the equator (in metres/second/second) is recorded in this field.
ECCENTRICITY	The eccentricity of a body's orbit is the difference between a circle and an ellipse. An eccentricity of 0 indicates that the body's orbit is perfectly circular.
INCLINATION	The inclination of a planet's orbit to the Earth-Sun orbital plane (Earth=0) or of a satellite's orbit to the equatorial plane of its planet is recorded in this field. The value is expressed in degrees.

ADDENDUM B

THE PRINTER

The ability to print the contents of any file or record in this package was a primary objective in its design.

Programs have been written to recognise a serial or parallel printer provided the interface card is located in **SLOT 1** of the computer. This is automatically the case for the Apple IIc computer. **DO NOT INSERT ANY CARD WHILE THE COMPUTER IS TURNED ON.**

If the printer can print screen graphics, it can be used to print histograms or slides when using Disk 2. There are some requirements which have to be met before this can be done. A printer configuration file must be set up using the **PRINTER CONFIGURATION** utility on Disk 2. This utility is accessed by selecting category 5 from the Main Menu.

At delivery, the package is configured to recognise an **IMAGEWRITER PRINTER** and a **SUPER SERIAL CARD.**

The computer will display at least 2 options, **IMAGEWRITER PRINTER** and **PARALLEL PRINTER.** Use the selection box to indicate the printer to be configured. If the Parallel Printer option is selected, the computer will request a control code. Following is a list of codes for the Automatic Ice card. Consult the printer manual if your printer and card is not on this list.

CARD	PRINTER	CONTROL CODE
Automatic Ice	Amust	Ctrl I G Q
	Apple Dmp	Ctrl I G I
	Case	Ctrl I G Q
	C. Itoh	Ctrl I G F
	Epson	Ctrl I G M
	Microline	Ctrl I G U
	NEC	Ctrl I G
	Prism	Ctrl I G P
	Seikosha	Ctrl I G S
	Star	Ctrl I G Q
	WP 1000	Ctrl I G Q
	Add D to the end of the code for full width printing.	
Digicard	Apple Dmp	Ctrl I G
	C. Itoh	Ctrl I G
	Epson	Ctrl I G
	Microline	Ctrl I G
	Star Gemini	Ctrl I G
	Add D to the end of the code for full width printing.	
	Add R to the end of the D code for printing lengthways.	

HAVING PROBLEMS?

THE BELL SOUNDS

This indicates that what is currently displayed on the screen cannot be printed.

NOTHING HAPPENS AND THE PROGRAM STOPS

There are a number of possible explanations for this:

1. the printer card is not in SLOT 1. check by removing the computer's cover. If a card is to be transferred or inserted, make sure the computer is turned off before doing so.

2. the printer is not turned on or the select mode has not been set for receive.

3. the printer has run out of paper (most printers emit a warning sound when this happens).

THE PRINTER WON'T PRINT HISTOGRAM GRAPHS OR MAPS

The Printer must be capable of printing screen graphics in addition to it being identified using the **PRINTER CONFIGURATION** utility on Disk 2. See above for details on how to do this.

If this is not the reason for the problem, check for other possible causes as per 1 to 3 above.

AND NOTHING FIXES THE PROBLEM

Boot the System Master and test the printer with direct commands. Write a short program and list it. If everything appears in working order, ring Know Ware Pty Ltd. on (042) 941829 or (042) 285513 giving details of your problem and equipment.

ADDENDUM C

ERROR CODES

CODE	MEANING	
4	Write Protected	This code indicates that data could not be stored on the diskette. Check that the write enable notch on the right hand side of the diskette is not covered. If it isn't, check the operation of the disk drive. Boot another disk, write a simple program and **SAVE** it. If a write protection error occurs, it is most likely the disk drive requires repair.
6	File Not Found	This code indicates that the required disk is not in drive 1. Do not switch disks until instructed to do so.
8	Input/Output Error	This code indicates that the computer could not load data or a program from the diskette. - make sure there's a disk in the drive. - make sure the drive's gate is closed. If both are affirmative, it is likely that either the diskette or disk drive is faulty. If the error occurs with only one of the diskettes in the package, it is likely that the diskette is faulty. The disk drive's read/write head may also require re-alignment. In such situations, errors are more likely to occur with other diskettes as well.
255	CTRL C has been entered	The program has been terminated by entering the break command, CTRL C.

RECOMMENDED RESOURCES

BOOKS

Moore, Patrick, **The New Atlas of the Universe**, Mitchell Beazley Publishers, London, 1984. Published in Australia by Reader's Digest Press, this is an excellent Atlas and resource. The style, pictures and illustrations are excellent (0 949819 46 8).

Moche, Dinah, **Astronomy Today**, Kingfisher Books Pty Ltd, London, 1984. A general book on the planets, stars and space exploration, Astronomy Today is easy to read and well laid out, but lacks depth (0 86272 105 9).

Couper, Heather, **The Planets**, Pan Books Ltd., London, 1985. This book is linked to the British seven part television series, The Planets. The content is organised in planet order starting with Mercury. The narrative style and the lack of illustrations let the book down. However, it is a worthwhile resource (0 330 290827).

Beatty, J., **The New Solar System**, Press Syndicate of the University of Cambridge, Massachusetts, USA, 1982. This book could be classed as a technical reference on the solar system. It is comprehensive and a very good reference book (0 521 27114 2).

Baker, David, **Conquest**, Windward, Holland & Clark Limited, 1984. This is a very good book on space flight. It includes numerous pictures supplied by NASA and other space agencies (0 7112 0403 9).

Wilson, Andrew, **Frontiers of Space**, Hamlyn Publishing Group Limited, 1985. A good and useful book on space flight (0 603 036759).

JUNIOR SOFTCOVERS

Finding out about the **Sun, Moon and Planets**, Usborne Explainers, Usborne Publishing Ltd., 1982 (0 86020 580 0).

Finding out about **Rockets and Spaceflight**, Usborne Explainers, Usborne Publishing Ltd., 1982 (0 72701 7241).

The Young Astronomer, Usborne Publishing Ltd., 1983 (0 72701 7217).

Planets and Galaxies, Hayes Publishing, Ashton Scholastic, Sydney, 1986 (0 86896 742 4).

Let's Read and Find Out series, **The Sun: Our Nearest Star**, A & C Black (0 7136 0051 9).

FILMS and SLIDES

Space Science prints (10), Britannica Education Services, North Sydney (cat. 18155).

Anglo-Australian Observatory slides (12), Vimiera Road, Epping 2121.

The Sun: our nearest star (film), CSIRO film and Video Centre, East Melbourne, 3002.

Satellites of the Sun (film), State Film Library, East Sydney. 2010.

PLACES TO VISIT

Mt Stromlo Observatory, Canberra, (062) 88 1111.

Parkes Radiotelescope, Beargamil, (068) 63 3131.

Perth Observatory, Bickley, Perth, (09) 293 8255.

Siding Springs Observatory, Coonabarabran, (068) 42 6262.

Sydney Observatory, Sydney, (02) 241 2478.

WORKSHEETS

WORKSHEET 1

Disk: 1
Main Menu Item: Files
Utilities: View File

Select **View File** and load the file **Solar System.**

1. What is the Solar System? .....

   .....

   .....

2. How much of the mass in the solar system is in the Sun? .....

3. How much bigger is the Sun than Earth? .....

Load the file **Sun.**

4. How old is the Sun? .....

5. What gases are found in the Sun? .....

6. How long does sunlight take to reach Earth? .....

7. What is the temperature at the Sun's core? .....

8. What is the temperature at the Sun's surface? .....

9. What is the Sun's diameter? .....

10. How long does the Sun take to complete an orbit around the centre of the Galaxy? .....

Worksheet 1 - Notes to assist

All the questions in worksheet 1 require the use of the **View File** utility with the files, **Solar System** and **Sun.**

1 to 3.

Select **Files** from the **Main Menu** and then the **View File** utility from the next menu. Select the file **Solar System** using the arrow keys to move the highlight box to the filename and the **RETURN** key to make the selection (the name fly-around is used from now on to describe this process).

The questions may be answered by reading the first page of text. Exit from the file by pressing the **ESC** key.

4 to 10.

Select **View File** again and then the file **Sun** using the fly-around.

The questions may be answered by reading the text. Use the arrow keys to move through the text. Exit from the file by pressing the **ESC** key.

General Comments

A **Help** screen can be displayed by pressing the **H** key during file display.

When viewing a file, use the arrow keys to scroll up or down through the file.

Rather than write down information found in the files, use the mark and print option to send the line or paragraph to a printer.

WORKSHEET 2

Disk: 1
Main Menu Item: Files
Utilities: View File and Word Search

Use **View File** to answer the following questions.

1. Load the **Dictionary**. What is a planet? .....

   .....

2. Load the file **Planets**. What does the word "planet" mean?

   .....

3. In what direction do the planets orbit the Sun? .....

   .....

4. What is a terrestrial planet? .....

5. Which planets are called the terrestrial planets? What are their main features?

   .....

   .....

   .....

   .....

6. What is a jovian planet? .....

7. Which planets are called the jovian planets? What are their main features?

   .....

   .....

   .....

8. What is unique about Pluto? .....

9. What is the other name for a minor planet? .....

10. Where are the minor planets mainly located? .....

Worksheet 2 - notes to assist

All the questions in this worksheet use the **View File utility** and **Search mode.**

1. Select **Files** from the Main Menu and then **View File** from the next menu. Select the file **Dictionary** using the fly-around. Use the arrow key to move down through the file to the title **planet.**

   Exit from the file by pressing the **ESC** key.

2. Select **View File** again and then the file **Planets.** The meaning of the word **planet** is contained in the first sentence.

3. This question can be answered from paragraph 1.

4. Press the **S** key to make a search from within the file. Enter the word **terrestrial** and press the **RETURN** key. The first occurrence of the word will be found and highlighted.

5 to 10.

   These questions can be answered by reading the current and following text screens.

General Comments

When viewing a file, use the arrow keys to scroll up or down through the file.

Upper and/or lower case characters can be used when entering search words.

When searching from within a file, it must be remembered that searching occurs from the current page. Use the **T** key to return to the top of the file if the whole file is to be searched.

Rather than write down information found in the files, use the mark and print option to send the line or paragraph to a printer.

WORKSHEET 3

Disk: 1
Main Menu Item: Files
Utilities: Word Search

Use the **Word Search** utility on individual files to answer the following questions.

1. Select the file **Astronomers.** Search the file for **Galileo.**

   What did Galileo make which led to his discoveries? .....

   What did he discover about Jupiter and Saturn? .....

   .....

   .....

   Who was the inventor of the reflecting telescope? .....

2. Select the file **History.** Search the file for **Galileo.**

   In what year did Galileo discover four of Jupiter's satellites? .....

   In what year did he discover Saturn's rings? .....

   In what year was Neptune discovered? .....

   Who discovered Neptune? .....

3. Select the file **Space Exploration.** Search the file for **First Satellite.**

   In what year was the first satellite launched? .....

   Which country launched it? .....

   When did the USA launch its first satellite? .....

4. Select the file **Moon.** Search the file for **Distance.**

   What is the Moon's average distance from Earth? .....

   What is the maximum distance? .....

   What is the minimum distance? .....

5. Select the file **Space Exploration.** Search the file for **Moon before 1960.**

   How many space probes were sent to the Moon before 1960? .....

Worksheet 3 - notes to assist

All questions in this worksheet use the **Word Search utility** on **single files**.

1. Select **Files** from the Main Menu, the **Word Search** utility from the next menu, the file **Astronomers** from the **Files Menu** and then enter **Galileo**. Press **RETURN** twice and the file will be loaded and the word highlighted. The first and second parts of the question can be answered from the text. The third part requires the student to press **S** for search and then enter **inventor of the reflecting telescope** or just **reflecting telescope**. The words will be found and then highlighted. The answer is contained in the text.

   Use the **ESC** key twice to exit.

2. Use **Word Search** to search the file **History** for **Galileo**. Load the file. The first and second parts of the question can be answered from the text. The third part requires the student to press **S** for search and then enter **Neptune**. The word will be found and highlighted.

   Use the **ESC** key twice to exit.

3. Search the file **Space Exploration** for **First Satellite**. Load the file. The first and second parts of the question can be answered from the text. The third part requires the student to press the **Spacebar** to search for the next occurrence of the words which will be found and highlighted.

   Use the **ESC** key twice to exit.

4. Search the file **Moon** for **Distance**. Load the file. The first part of the question can be answered from the text. The second and third parts require the student to press the **Spacebar** to search for the next occurrence of the word.

   Use the **ESC** key twice to exit.

5. Select **Word Search** again, the file **Space Exploration** and then enter **Moon before 1960**. Press **RETURN** twice and the file will be loaded and the word **Moon** highlighted. The question can be answered from the text.

   Use the **ESC** key twice to exit.

General Comments

When viewing a file, use the arrow keys to scroll up or down through the file.

Upper and/or lower case characters can be used when entering search words.

When searching from within a file, it must be remembered that searching occurs from the current page. Use the **T** key to return to the top of the file if the whole file is to be searched.

Rather than write down information found in a file, use the mark and print option to send the line or paragraph to a printer.

WORKSHEET 4

Disk: 1
Main Menu Item: Files
Utilities: Word Search

Use the **Word Search** utility on **All** files to answer the following questions.

1. Which planets have no satellites? .....

2. What is the name of the smallest planet? .....

   What is its diameter? .....

   What is its position from the Sun? .....

3. What is the name of the second smallest planet? .....

   What is its diameter? .....

   What is its position from the Sun? .....

4. What is the name of the largest planet? .....

   How many Earths could it hold by volume? .....

   What is its diameter? .....

   What is its position from the Sun? .....

5. What does Greenhouse Effect mean? .....

   .....

   .....

   Which planet suffers from this effect? .....

   What has it done to the planet? .....

   .....

   .....

   .....

Worksheet 4 - notes to assist

All questions in this worksheet use the **Word Search utility** on **All** files.

1. Select **Word Search** and then **All** from the **Files Menu**. Enter **No Satellites** as the search request. All files will now be searched with a continuous progress report displayed on the screen. Press the **RETURN** key at the completion of the search. The question can be answered from the list. If necessary, load the first file **Planets** and read the text for the answer.

   Use the **ESC** key twice to exit.

2. Use the **Word Search** utility to search **All** files. The search request can take either of two forms. If **Smallest Planet** is entered, two files will match since one has a reference to being the second smallest planet. If **The Smallest Planet** is entered, only one file will match. The rest of the question may be answered by scrolling through the text to the data section at the end of the file.

   Use the **ESC** key twice to exit.

3. Whether another search of the files is necessary to answer this question depends on how question 2 was answered. If the search request was **The Smallest Planet**, then another search will be necessary using the search request **Second Smallest Planet**. The rest of the question may be answered by scrolling through the text to the data section at the end of the file.

   Use the **ESC** key twice to exit.

4. Select **Word Search** and then **All** from the **Files Menu**. Enter **The Largest Planet** as the search request. On pressing the **RETURN** key at the completion of the search, the file name of the largest planet will be listed. Load the file and search (press **S**) for **Volume** to answer the second part of the question. The rest of the question may be answered by scrolling through the text to the data section.

   Use the **ESC** key twice to exit.

5. This question again uses **Word Search** and **All** from the **Files Menu**. Enter **Greenhouse Effect** as the search request. Press the **RETURN** key at the completion of the search. Two files will then be listed. Both files must be accessed.

   Use the **ESC** key twice to exit.

General Comments

When viewing a file, use the arrow keys to scroll up or down through the file.

Upper and/or lower case characters can be used when entering search words.

When searching from within a file, it must be remembered that searching occurs from the current page. Use the **T** key to return to the top of the file if necessary.

Rather than write down information found in the files, use the mark and print option to send the line or paragraph to a printer.

WORKSHEET 5

Disk: 1
Main Menu Item: Files
Utilities: Word Search

Use the **Word Search** utility on **All** files to answer the following questions.

1. What is the name of the satellite with a major atmosphere? .....

   How big is it compared to other satellites in the solar system? .....

   What does it have in common with Earth? .....

2. Which planet has water and air and life? .....

   What do no other planets in the solar system have? .....

3. Which planet has satellites named Phoebe, Mimas and Hyperion? .....

   What is unique about Mimas? .....

4. List details of the accidents in which men and women have been killed or injured in the conquest of space? .....

   .....

   .....

   .....

   .....

   .....

   .....

5. In what year was the first space probe successfully sent to Mercury or Venus? .....

   Which country launched the probe? .....

Worksheet 5 - notes to assist

All questions in this worksheet use the **Word Search utility** on **All** files.

1. Select **Word Search** and then **All** from the **Files Menu**. Enter **Satellite and Major Atmosphere** as the search request. Note that this request uses the **AND** connector. Press the **RETURN** key at the completion of the search and then load the listed file. The **Spacebar** should be pressed until the paragraph containing both parts of the search request is displayed. The question can be answered from the text.

   Use the **ESC** key twice to exit.

2. Search **All** files for **Water and Air and Life**. Note that this request uses the **AND** connector twice. Press the **RETURN** key at the completion of the search and then load the listed file. The second part of the question can be answered from the text.

   Use the **ESC** key twice to exit.

3. Search **ALL** files for **Phoebe and Mimas and Hyperion**. This question also requires the use of the **AND** connector. Press the **RETURN** key at the completion of the search and then load the listed file. The second part of the question can be answered from the text.

   Use the **ESC** key twice to exit.

4. Search **All** files for **Killed or Injured**. This question uses the **OR** connector. Press the **RETURN** key at the completion of the search and then load the listed file. The question can be answered from the text. Use the **Spacebar** to find the next occurrences of the word(s).

   Use the **ESC** key twice to exit.

5. Search **All** files for **Mercury or Venus**. This question also uses the **OR** connector. Press the **RETURN** key at the completion of the search and then load the listed file. The question can be answered from the text.

   Use the **ESC** key twice to exit.

General Comments

When viewing a file, use the arrow keys to scroll up or down through the file.

Upper and/or lower case characters can be used when entering search words.

When searching from within a file, it must be remembered that searching occurs from the current page. Use the **T** key to return to the top of the file if the whole file is to be searched.

Rather than write down information found in the files, use the mark and print option to send the line or paragraph to a printer.

WORKSHEET 6

Disk: 2
Main Menu Item: Slides
Utilities: Nil

1. Load the **Eclipses** sequence of slides and motion.

   What is the Earth-Sun orbital plane called? .....

   Eclipses don't occur every month. Why not? .....

   .....

   .....

   What is a Lunar Eclipse? .....

   .....

   What is a Total Solar Eclipse? .....

   .....

2. Load the **Neptune & Pluto** motion sequence.

   Is Pluto ever closer to the Sun than Neptune? .....

   Why? .....

3. Load the **Orbit Types** motion sequence.

   In what direction does Phoebe orbit Saturn? .....

   What name is given to this type of orbit? .....

4. Load the slide **Seasons - December.**

   What season is it in the Northern Hemisphere in December? .....

   Why? .....

5. Load the slide **Seasons - June.**

   What season is it in the Northern Hemisphere in June? .....

   Why? .....

Worksheet 6 - Notes to assist

All the questions in worksheet 6 are designed to familiarise students with the content of the **Slides** option.

1. Select the **Slides** option from the **Main Menu** and then **Eclipses (M)** from the **Slides Menu**. The questions can be answered by displaying the slides in sequence. Use the **RETURN** key to proceed through the display.

   Use the **ESC** key to exit back to the **Slides Menu**.

2. Select **Neptune & Pluto (M)** from the **Slides Menu**. The questions can be answered from the display.

   Use the **ESC** key to exit back to the **Slides Menu**.

3. Select **Orbit Types (M)** from the **Slides Menu**. The questions can be answered from the display.

   Use the **ESC** key to exit back to the **Slides Menu**.

4. Select **Seasons - December** from the **Slides Menu**. The questions can be answered from the display.

   Use the **ESC** key to exit back to the **Slides Menu**.

5. Select **Seasons - June** from the **Slides Menu**. The questions can be answered from the display.

   Use the **ESC** key to exit back to the **Slides Menu**.

General Comments

Any display screen can be sent to an online printer by pressing the **P** key. The printer must be capable of printing screen graphics and have been previously configured using **option 5** from the **Main Menu**.

WORKSHEET 7

Disk: 2
Main Menu Item: Exploration Database
Utilities: Histogram Graphs

Select the **Exploration Database** from the **Main Menu** and the option **Analyse 1 Field <BY> all its Items.**

1. Analyse the field **Country.**

   How many of the flights in the database were launched by the USA? .....

   How many were launched by the USSR? .....

2. Analyse the field **Crew?**

   How many manned flights have there been? .....

   How many flights have had 4 or more crew? .....

3. Analyse the field **Destination.**

   How many flights have been sent to the Moon? .....

   How many probes have been sent to Mars? .....

   Select **Graph Results** from the **Search Finished Menu.**

   Ignoring Earth orbit launches, what does the graph show about exploration launches to date? .....

   .....

Select the **Exploration Database** again and the option **Analyse Fields <BY> and <WITH>.**

4. Analyse the field **Destination with CREW > 0.**

   How many manned flights have gone to the Moon? .....

   How many manned flights have orbited Earth? .....

5. Analyse the field **Country** with **Destination = Moon.**

   Which country has sent the most flights to the Moon? .....

Worksheet 7 - notes to assist

All the questions in this worksheet are designed to familiarise students with two of the database search options and the histogram graphing utility.

Questions 1 to 3 require the selection of **one field only** from the **Fields Menu.** The computer will analyse the selected field and display all the Field Items and their values for that field. The answer to the Histogram graphing exercise in question 3 is that man's "conquest" of space has been limited to Earth's nearest neighbours, the Moon, Venus and Mars.

Questions 4 and 5 require the selection of one field from the **BY Fields Menu** and another field from the **WITH Fields Menu.** On selecting the second field, the student must choose **No More Fields, an operator (> for question 4 and = for questions 5) and a field item.** All the Field Items and their values for the **BY** field will be displayed.

If required, the results of any analysis can be sent to a printer by pressing the **P** key.

After the analysis results are displayed, a **Search Finished Menu** will be displayed on pressing either the **ESC** or **RETURN** key. The **See the List Again** option may be used to look at the analysis results again. The **Another Analysis** option must be used to do another search by returning to the **Fields Menu.**

WORKSHEET 8

Disk: 2
Main Menu Item: Solar System Database
Utilities: Histogram Graphs

Select the **Solar System Database** from the **Main Menu** and the option **Analyse 1 Field <BY> all its Items.**

1. Analyse the field **Type.**

   How many known planets are in the solar system? .....

   How many known natural satellites are in the solar system? .....

2. Analyse the field **Rings.**

   How many planets have rings? .....

3. Analyse the field **Orbit.**

   How many planets and satellites have direct (counter-clockwise) orbits? .....

   How many have retrograde (clockwise) orbits? .....

Select **Change Search Option** and then **Analyse Fields using <BY> and <WITH>.**

4. Analyse the field **Type** with **Orbit = Retrograde.**

   Do any planets have retrograde orbits? .....

   How many satellites have retrograde orbits? .....

5. Analyse the field **Distance** with **Central Body = Sun.**

   Graph the results. Send the graph to a **printer or copy** it. Press **ESC** to exit. Select the **Solar System Database** and then the second option.

   Analyse the field **Orbital Period** with **Central Body = Sun.**

   Graph the results. Send the graph to a **printer or copy** it.

   Do the two graphs suggest a relationship between distance from the Sun and orbital period? .....

   If so, what in general is the relationship? .....

   .....

Worksheet 8 - notes to assist

All the questions in this worksheet are designed to familiarise students with two of the database search options and the histogram graphing utility.

Questions 1 to 3 require the selection of **one field only** from the **Fields Menu.** The computer will analyse the selected field and display all the Field Items and their values for that field.

Questions 4 and 5 require the selection of one field from the **BY Fields Menu** and another field from the **WITH Fields Menu.** On selecting the second field, the student must choose **No More Fields, an operator (=) and a field item.** All the Field Items and their values for the **BY** field will be displayed.

The main emphasis of question 5 is on the use of the Histogram Graphing utility. It involves two analyses, the graphing of both of them and then the visual interpretation of the results. The utility is selected from the **Search Finished Menu.**

If required, the results of any analysis can be sent to a printer by pressing the **P** key.

After the analysis results are displayed, a **Search Finished Menu** will be displayed on pressing either the **ESC** or **RETURN** key. The **See the List Again** option may be used to look at the analysis results again. The **Another Analysis** option must be used to do another search by returning to the **Fields Menu.**

WORKSHEET 9

Disk: 2
Main Menu Item: Solar System Database
Utilities: Format

Select the **Solar System Database** from the **Main Menu** and the option **Analyse Fields with 1 Item Each.**

1. Which planets have satellites? .....

   .....

2. The Moon's diameter is 3 476 km. Which satellites are larger? .....

3. Which planets have rings? .....

4. Which satellites have retrograde orbits? .....

   .....

5. What is the diameter of Earth? .....

6. Which planets are larger than Earth? .....

   .....

7. Which planets are smaller than Earth? .....

8. What are the planets' names? (**Type = Planet**) .....

   .....

   Select the **Format** utility.

   List the planets in their order from the Sun.
   (select **Position to C.B.** and **Name**) .....

   .....

   List the planets and their diameters in terms of size to the Sun.
   (select **Size to C.B.**, **Name** and **Diameter**) .....

   .....

Worksheet 9 - notes to assist

The questions in this worksheet require the selection of at least one field from the **Fields Menu**, an **operator** such as = or > for each field, **a field item** for each field and with most questions, the **AND** connector.

The main emphasis of question 8 is on the **Format** utility. This utility is selected from the **Search Finished Menu.**

The **Search Requests** should be:

1. **Satellites > 0**

2. **Type = Satellite and Diameter > 3476**

3. **Rings = Present**

4. **Type = Satellite and Orbit = Retrograde**

5. **Name = Earth**

6. **Type = Planet and Diameter > 12756**

7. **Type = Planet and Diameter < 12756**

8. **Type = Planet**

If required, the results of any analysis can be sent to a printer by pressing the **P** key.

After the analysis results are displayed, a **Search Finished Menu** will be displayed on pressing either the **ESC** or **RETURN** key. The **See the List Again** option may be used to look at the analysis results again. The **Another Analysis** option must be used to do another search by returning to the **Fields Menu.**

WORKSHEET 10

Disk: 2
Main Menu Item: Exploration Database
Utilities: Format

Select the **Exploration Database** from the **Main Menu** and the option **Analyse Fields with 1 Item Each.**

1. How many space flights have had more than three crew members? .....

   What craft did they use? .....

2. How many missions to Mars failed? .....

3. How many flights to Mars launched by the USSR failed? .....

4. How many manned flights landed on the Moon? .....

5. How many space probes have successfully landed on Mars? .....

6. How many manned flights were made in 1986? .....

7. Search the database for **Destination = Mars.** Select the **Format** utility. Select the fields **Year of Launch, Purpose, Country** and **Results.**

   In what year did the first successful flight occur? .....

   Which country has had the most number of successful flights to Mars? .....

   When did the last flight occur? .....

8. Search the database for **Destination = Venus or Destination = Venus Mercury.** Select the **Format** utility. Select the fields **Year of Launch, Purpose, Country** and **Results.**

   In what year did the first successful flight occur? .....

   When was the first successful landing on Venus? .....

   Which country has had the most number of successful flights to Venus? .....

Worksheet 10 - notes to assist

The questions in this worksheet require the selection of at least one field from the **Fields Menu**, an **operator** such as = or **>** for each field, **a field item** for each field and with most questions, the **AND** or **OR** connector.

The main emphasis of questions 7 and 8 is on the **Format** utility. This utility is selected from the **Search Finished Menu.**

The **Search Requests** should be:

1. **Crew > 3**

2. **Destination = Mars and Result = Failed**

3. **Destination = Mars and Country = USA and Result = Failed**

4. **Destination = Moon and Purpose = Land and Crew > 0 and Result = Success**

5. **Destination = Mars and Purpose = Land and Result = Success**

6. **Crew > 0 and Year of Launch = 1986**

7. **Destination = Mars**

8. **Destination = Venus or Destination = Venus Mercury**

If required, the results of any analysis can be sent to a printer by pressing the **P** key.

After the analysis results are displayed, a **Search Finished Menu** will be displayed on pressing either the **ESC** or **RETURN** key. The **See the List Again** option may be used to look at the analysis results again. The **Another Analysis** option must be used to do another search by returning to the **Fields Menu.**

ACTIVITIES

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ACTIVITY 1 - The Sun

Display sheets 8 and 9 together with the files **Sun** and **Stars** may be used for this activity. Drawings or photocopies of the display sheets should be used where practical.

The Sun is a star amongst millions of stars. The other stars look tiny because they are so far away. What is the relative size of the Sun to the other stars? Which types are larger and which smaller? Use drawings or cut-outs with your answers.

Write a story on the life of the Sun. What will eventually happen to it and the Earth?

Prepare a Project Sheet on the Sun describing its composition, structure, surface activity, orbit and rotation. Also describe how it appears at different times of the year from the Earth's surface.

ACTIVITY 2 - The Planets

Select one of the planets in the solar system. Prepare a Project Sheet on the planet making sure it has drawings, diagrams, figures and a story. Look through the display sheets for material you can draw or photocopy for use in your Project Sheet. Obtain a print-out of the planet's file.

Your Project Sheet should include:

a large coloured drawing of the planet showing what you think are its main features. This drawing must be your own and must be labelled.

a diagram showing the internal structure of the planet.

other diagrams, drawings or cut-outs you think will help others learn about your planet. Use your own words to describe what's in the drawings. Make sure your descriptions are near the drawings.

In addition to drawings and diagrams, you must write a brief story on the planet. Include a figures section (at the end perhaps). This section must have the figures for

position and distance from the Sun, diameter, orbital period, rotation period, density, temperature, atmosphere, number of satellites, mass compared to Earth (Earth=1) and volume compared to Earth (Earth=1).

ACTIVITY 3 - The Moon

Prepare a Project Sheet on the Moon making sure it has drawings, diagrams, figures and a story. Study display sheets 6 and 7 for any material you can draw or photocopy for use in your project. Obtain a print-out of the file **Moon.**

Include in your Project Sheet a drawing (or picture) of the Moon and another showing its size in relation to Earth.

Explain why the Moon shines. Describe its surface.

Explain why the Moon appears to change shape. Use diagrams or cut-outs with your answer.

Also write a brief story on the Moon. Include a figures section (at the end perhaps). This section should have the figures for

distance from Earth, diameter, orbital period, rotation period, density, temperature, gravity, atmosphere and mass compared to Earth (Earth=1).

ACTIVITY 4 - Halley's Comet

Display sheet 17, the file **Comets** and books from your school or local library may be used for this activity. Drawings or photocopies of all or part of the display sheet should be used where practical.

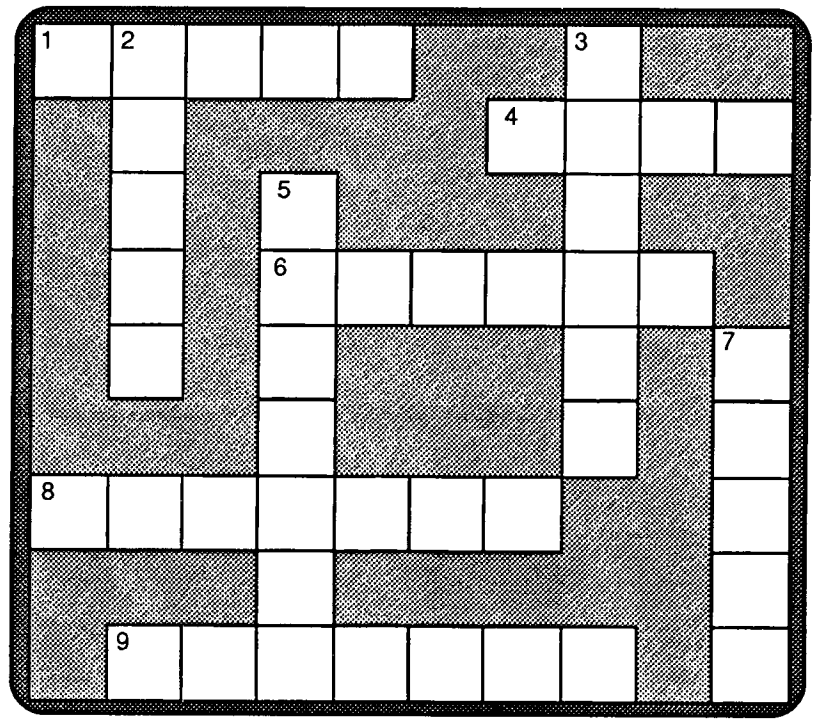
Prepare a Project Sheet on comets describing their composition, structure and orbit. Write a story on them.

Also include a story on Halley's Comet. How did the comet get its name? Use a diagram to show its orbit around the Sun.

Use drawings or photocopies in both parts of your Project Sheet.

Find details on other comets. Prepare a list showing each comet's name, orbital period and the year it was last seen.

ACTIVITY 5 - Planets Crossword



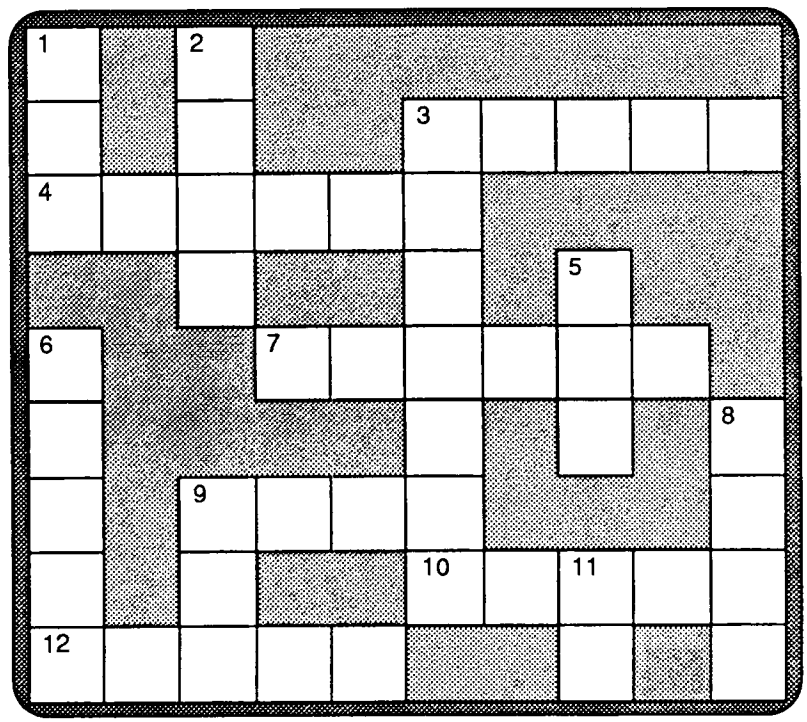
Across

1. The brightest planet in the sky.
4. Deimos is a satellite of this planet.
6. Voyager 2 flew past this planet in 1986.
8. The planet named after the Roman god of the sea.
9. The closest planet to the Sun.

Down

2. The only known planet with life forms.
3. A pretty planet with rings.
5. The largest planet in the solar system.
7. The smallest and most distant planet in the solar system.

ACTIVITY 6 - General Crossword



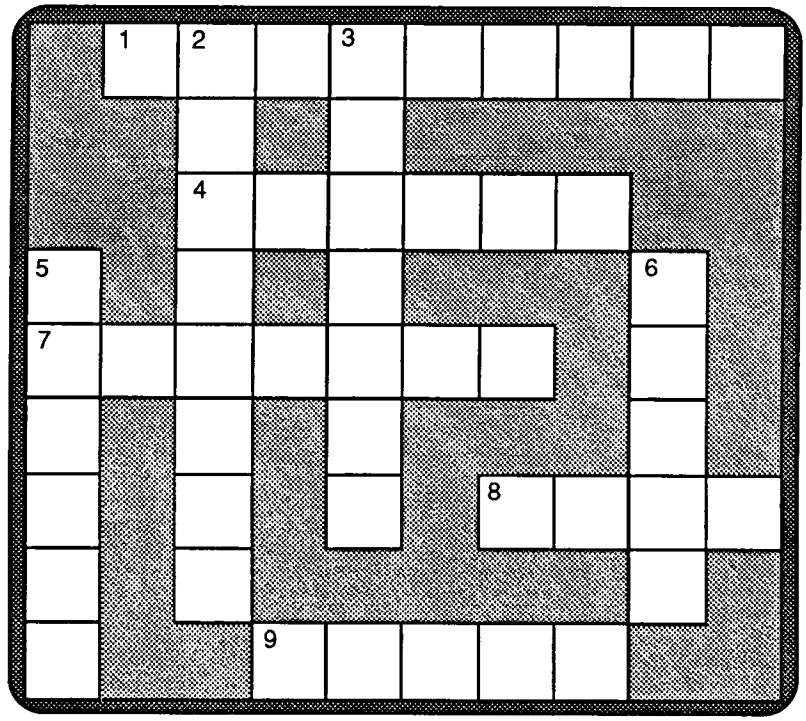
Across

3. The second planet from the Sun.
4. The name given to the space programme which saw man set foot on the Moon.
7. Voyager 2 discovered 10 new satellites orbiting this planet.
9. How many satellites orbit Mercury?
10. What Saturn is famous for.
12. The only known satellite with a major atmosphere.

Down

1. The country which sent the first successful space probe to orbit Mars.
2. Earth's only natural satellite.
3. The name given to two space probes sent to fly-by the outer planets.
5. All the planets are bound to this celestial body.
6. The path followed by a planet or satellite.
8. The country to first put man into space.
9. The Moon is or is not the largest satellite in the solar system.
11. Was Pluto the furthest planet from the Sun in 1986?

ACTIVITY 7 - Dictionary Crossword



Across

1. An artificial or natural body (a moon) that orbits a larger body such as a planet.
4. The second most common element in the universe.
7. The result of a celestial body passing through the shadow of another body.
8. An imaginary line through the centre of a body about which the body rotates.
9. Electromagnetic radiation visible to the human eye.

Down

2. The point in the orbit of a planet that is furthest from the Sun.
3. The oval path of a planet or comet.
5. It makes a streak of light in the night sky.
6. The path followed by a body as it revolves around another body.

ACTIVITY 8 - The Planets

Complete the table by identifying the year for each discovery.

Year	Discovery
.....	Tombaugh discovered Pluto
.....	Hall discovered Deimos and Phobos
.....	Galle discovered Neptune
.....	Herschel discovered Uranus
.....	Galileo discovered 4 of Jupiter's satellites

Complete the table by identifying the planet with the listed feature.

Planet	Feature
.....	has a carbon dioxide atmosphere
.....	would float in water
.....	has a huge Red Spot on the surface
.....	is heavily cratered like the Moon
.....	is the only planet with water, air and warmth

ACTIVITY 9 - The Planets

Match the planet with its position from the Sun.

Position			Planet
1st	.....	(a)	Earth
2nd	.....	(b)	Pluto
3rd	.....	(c)	Saturn
4th	.....	(d)	Mercury
5th	.....	(e)	Jupiter
6th	.....	(f)	Uranus
7th	.....	(g)	Venus
8th	.....	(h)	Mars
9th	.....	(i)	Neptune

Match the planet with its diameter.

Diameter			Planet
3000	.....	(a)	Earth
4878	.....	(b)	Pluto
6794	.....	(c)	Saturn
12104	.....	(d)	Mercury
12756	.....	(e)	Jupiter
49500	.....	(f)	Uranus
52400	.....	(g)	Venus
120000	.....	(h)	Mars
142800	.....	(i)	Neptune

ACTIVITY 10 - Satellites

Match the satellite to its planet.

Planet			Satellite
Earth	.....	(a)	Ganymede
Pluto	.....	(b)	Titan
Saturn	.....	(c)	Moon
Mercury	.....	(d)	Triton
Jupiter	.....	(e)	Deimos
Uranus	.....	(f)	Charon
Venus	.....	(g)	Oberon
Mars	.....	(h)	None
Neptune	.....	(i)	None

Match the satellite with its diameter.

Diameter			Planet
5262	.....	(a)	Callisto
5150	.....	(b)	Rhea
4800	.....	(c)	Europa
3630	.....	(d)	Ganymede
3500	.....	(e)	Oberon
3476	.....	(f)	Io
3138	.....	(g)	Moon
1600	.....	(h)	Titan
1530	.....	(i)	Triton

ACTIVITY 11 - The Moon

Answer these questions with a word or a figure.

Is the Moon's gravity less than that of Earth? .....

Would a person weigh more or weigh less on the Moon? .....

Would a person jump higher on the Moon than on Earth? .....

Does the Moon have an atmosphere? .....

Does the Moon have weather and storms? .....

Can a person make and hear sounds on the Moon? .....

Is there water on the Moon's surface? .....

What is the Moon's surface covered by? .....

Is the Moon's far side different to the side facing Earth? .....

Does the Moon's soil contain some oxygen? .....

ACTIVITY 12 - Space Exploration

Match these achievements with a country.

Which country in

1957 launched the first satellite? .....

1959 sent the first space probe to photograph the Moon? .....

1960 launched the first weather satellite? .....

1961 made the first manned orbital flight? .....

1962 sent the first space probe to fly-by another planet? .....

1963 sent the first woman into space? .....

1965 sent the first space probe to fly-by Mars? .....

1966 made the first unmanned soft landing on the Moon? .....

1969 made the first manned landing on the Moon? .....

1970 sent the first space probe to land on Venus? .....

1971 sent the first space probe to orbit another planet? .....

1973 launched the first space probe to fly-by Jupiter? .....

1974 launched the first two-planet space probe? .....

1979 sent the first space probe to fly-by Saturn? .....

1981 launched the first space shuttle? .....

1986 sent the first space probe to fly-by Uranus? .....

ACTIVITY 13 - Stars

The Sun is a star amongst millions of stars. They vary in size, colour and brightness. Use display sheet 9, the files **Stars** and **Sun**, and the **Slides** section for this activity.

What is a star? Why does it shine?

Is the Sun a small, average or large star?

What is the Sun's diameter? What is its surface temperature?

How is a star "born"?

Why are some stars brighter than others?

What is the colour and temperature of the hottest stars?

Describe the life cycle of an average star. Use diagrams in your description.

Describe the life cycle of a large star. Use diagrams in your description.

ACTIVITY 14 - The Solar System

Display sheet 10, the file **Solar System** and books from your school or local library should be used for this activity.

What is the solar system?

What controls all bodies in the solar system? Why?

According to current thinking, how was the solar system formed?

Describe the solar system and its members using diagrams to show the positions and orbits of the planets in relation to the Sun.

Which three planets have very oval type orbits?

ACTIVITY 15 - The Planets

Display sheet 11 and the files **Dictionary** and **Planets** may be used for this activity.

What is a planet?

Name the planets in the Solar System in their order from the Sun.

Which is the largest planet in the Solar System?

Which is the smallest?

Which of these two planets would you weigh more on?

Which would you weigh less on?

Why don't the planets collide with each other?

ACTIVITY 16 - The Planets

Display sheets 12 and 14, the files section, the Solar System Database and books from your school or local library should be used for this activity.

Which planet has an axis almost on the same plane as its orbit? How many years does each side spend in sunlight and then in darkness?

Which planet has the shortest day (ie. the fastest rotation speed)? What is unique about the size of the planet?

Which planet has a large metal core? What does its surface look like?

Search the database for **Type = Planet** and use the Format utility to answer the following questions.

Which planet has the largest number of natural satellites? For what feature is the planet well known?

Which planets have an inherent magnetic field (ie one that is not generated by an ionosphere)? Of these, which would have the largest magnetic field?

ACTIVITY 17 - Earth

Display sheets 5 and 12, and the files **Dictionary** and **Earth** may be used for this activity.

What is a planet's **axis**?

What is meant by **axis tilt**? What is the axis tilt of Earth?

Why does the Earth have seasons?

What season is it in the Northern Hemisphere at Christmas?

What season is it in the Southern Hemisphere?

Which season has the longest days (from sunrise to sunset)?

Which season has the shortest days?

How much daylight does the north pole have during its summer?

How much night does the south pole have during its winter?

ACTIVITY 18 - Earth

Display sheet 1 and the files **Dictionary** and **Earth** may be used for this activity.

What does the term **orbital period** mean?

What is Earth's orbital period (in days)? What name do we call this period?

How fast (orbital velocity) does the Earth orbit the Sun? What is this speed in km per hour?

Why are there days and nights on Earth?

In what part of the sky does the Sun rise? In what part does it set?

What is meant by **rotation period**? What is Earth's rotation period?

ACTIVITY 19 - The Earth

The Earth's size, distance from the Sun and other features make it the most suitable planet in the solar system for the support of life.

Is this statement true? List those features which make Earth unique and support life.

If the Earth was significantly closer to the Sun, what would happen to its seas, its temperature, its climate and its life forms?

What would happen in these areas if Earth was significantly further from the Sun?

If the Earth had been as small as Mars, would it have retained its water and an atmosphere? Give reasons for your answer.

ACTIVITY 20 - Eclipses

Use display sheet 3 and the **Slides** section for this activity.

Why do eclipses occur?

Eclipses don't occur every month because of the Moon's orbital tilt. Explain this statement.

What is a solar eclipse? Draw a diagram (with labels) of a total solar eclipse.

How many types of solar eclipses are there? What are their names? How are they different?

How does a lunar eclipse occur? Draw a diagram (with labels) of a lunar eclipse.

During an eclipse, a shadow is formed behind the body facing the Sun. What is the central part of this shadow called? What is the border part called?

ACTIVITY 21 - Tides

Use display sheet 4 for this activity.

Why do tides occur in Earth's oceans? Use a diagram of the Earth and the Moon to explain your answer.

How often do the tides change? Where would be the greatest change in tidal height? Why?

What are spring tides and neap tides? Explain with diagrams.

ACTIVITY 22 - The Satellites

The Solar System Database, the files section and other material may be used for this activity.

Which satellite has a major atmosphere? Describe the satellite, name its host planet and name the similarities between the satellite and Earth.

Which satellite is the largest satellite in the solar system? Describe the satellite, name its host planet and compare it to Mercury and the Moon.

Which satellite is the most active body in the solar system? Describe the satellite, name its host planet and explain why it is so active.

ACTIVITY 23 - Jupiter's Satellites

The four largest satellites orbiting Jupiter are Io, Europa, Ganymede and Callisto.

Describe these satellites and their features. Give details on diameter, orbital period, distance from Jupiter, type of orbit and composition.

Prepare a diagram showing their orbital paths around Jupiter.

ACTIVITY 24 - Jupiter's Satellites

Jupiter is the largest planet in the solar system. It is surrounded by a host of natural satellites. Search the Solar System Database for a list of the satellites (**Central Body = Jupiter**) and then use the Format utility for the following:

How many satellites orbit Jupiter?

List these satellites in order from Jupiter (the list must include the satellite's position, name and distance).

List them in order by size from smallest to largest (the list should comprise the satellite's name and diameter).

How many have retrograde orbits? What are their names?

Obtain a printout of their order by size to central body (C.B.) with name, year discovered, position to central body (C.B.) and diameter. What does the list show about Earth-based astronomy.

ACTIVITY 25 - Saturn's Rings

Saturn is well known for its rings. Other planets also have rings, but they are insignificant compared to those of Saturn. Use the file **Saturn**, the Solar System Database and books from your school or local library for this activity.

What do the rings around Saturn consist of? Why do they shine? Who first discovered these rings and in what year?

Describe Saturn's ring system. Describe what we see at various times from Earth.

Which other planets have rings?

ACTIVITY 26 - Saturn's Satellites

Saturn is the second largest planet in the solar system. It is surrounded by a host of natural satellites. Search the Solar System Database for a list of the satellites (**Central Body = Saturn**) and then use the Format utility for the following:

How many satellites orbit Saturn?

List these satellites in order (their position) from Saturn (the list must include the satellite's position, name and distance).

List them in order by size from smallest to largest (the list should comprise the satellite's name and diameter).

How many have retrograde orbits? What are their names?

Obtain a printout of their order by size to central body (C.B.) with name, year discovered, position to central body (C.B.) and diameter. What does the list show about Earth-based astronomy.

ACTIVITY 27 - Neptune and Pluto

Neptune and Pluto are the two known outermost planets in the solar system. Use the files on **Neptune** and **Pluto** and the **Slides** section for this activity.

How was Neptune discovered, by whom and in what year?

How was Pluto discovered, by whom and in what year?

What is unusual about Pluto's orbit? Draw a diagram showing the orbits of both Pluto and Neptune.

A number of astronomers think Pluto is an asteroid. What do you think? Why?

Many astronomers believe there must be a 10th planet beyond Pluto. Why do they believe this? Why would it be difficult to find this planet?

ACTIVITY 28 - Asteroids

Use the files **Asteroids** and **History**, and books from your school or local library for this activity.

What is an asteroid?

When and by whom was the first asteroid discovered?

Where is the greatest number of asteroids? Draw a diagram showing the orbits of Mars, the asteroid belt and Jupiter.

According to Kepler's laws, the asteroid belt is in an orbital path which should be occupied by a planet. What could this show about the origin of a large number of the asteroids in this belt?

What is the name of the largest asteroid? Describe it.

Do any asteroids cross Earth's orbit? What could happen if one collided with our planet (assume two cases: one impacting on solid earth and the other in an ocean)?

ACTIVITY 29 - Meteors, Meteoroids and Meteorites

Meteors or "falling stars" are visible on any clear night as they burn up in Earth's atmosphere. Use display sheet 18 and the files **Dictionary** and **Meteoroids** for this activity.

What are "falling stars"?

What are meteoroids, meteors and meteorites?

What is a "meteor shower"?

Describe the Leonid Meteor Stream.

ACTIVITY 30 - Apparent Motion

When Mars approaches opposition, it appears from Earth to stop its forward motion across the night sky and to backtrack on its orbital path for a few weeks. The apparent motion of Mars is thus different to its real motion.

With the aid of a diagram, explain what is meant by Opposition (see display sheet 20).

Describe the true motions and orbits of Mars and Earth. Give details of their orbital speeds.

With the aid of a diagram, describe the (apparent) motion of Mars as seen from Earth (see display sheet 19).

ACTIVITY 31 - Orbital Planes

The solar system is described as pancake looking. Use display sheet 13 and the file **Solar System** to explain what this means?

Which planet has an unusual orbital plane? Why is it unusual?

What is the plane of the ecliptic? Use a labelled diagram to describe it.

ACTIVITY 32 - Magnetosphere

Use display sheet 2, the file **Magnetosphere** and books from your school or local library for this activity.

What are the Van Allen radiation belts? Draw a diagram of Earth and the belts. What purpose do they serve?

Describe Earth's magnetosphere, its structure and its importance to life on this planet. Use labelled diagrams to support your description.

ACTIVITY 33 - Gravitation

The principle that explains why the Moon orbits Earth which in turn orbits the Sun was explained by Isaac Newton in his laws on gravitation and motion.

What is gravitation?

Write a story on Newton's contribution to physics and astronomy.

How fast does the Earth move around the Sun (in km/hour)?

If the Earth were to stop, what would happen to it?

With the help of diagrams, explain why the Earth (or any other planet) stays in its orbit around the Sun.

ACTIVITY 34 - Density

Except for Pluto, the planets are divided into two groups, the terrestrial or Earth-like planets and the jovian or Jupiter-like planets. The jovian planets are also called the "gas giants".

Use the Solar System Database to draw a histogram graph of the densities of the planets (search the database by the field **Density** with **Central Body = Sun**. Graph the results).

Use the Graph to identify and list the planets into the two groups referred to above. Don't worry about Pluto - it's in a group of its own.

What does density mean? The density of water is 1 gm per cubic cm. What does this suggest about Saturn (imagine Saturn being dropped into a huge sea)?

ACTIVITY 35 - Diameter

The jovian or Jupiter-like planets are often called the "gas giants". They may be identified by their density or size.

Use the Solar System Database to draw a histogram graph of the diameters of the planets (search the database by the field **Diameter** with **Central Body = Sun**. Graph the results).

List, in size order, the four planets which form the jovian group.

Excluding Pluto, what is the name given to the other group of planets? Why?

ACTIVITY 36 - Eccentricity

Display sheet 10 and the Solar System Database should be used for this activity.

What does eccentricity mean? Use a diagram of Pluto's orbit to explain the concept.

Use the Solar System Database to draw a histogram graph of the eccentricity values for the planets (search the database by the field **Eccentricity** with **Central Body = Sun**).

Which planet has the highest eccentricity? What is its value? What is unique about its orbit?

Order the eccentricity values for the planets from the highest value to the lowest value. Write the name of the planet against its eccentricity.

ACTIVITY 37 - Planetary Motion

Johannes Kepler proposed three laws of planetary motion. This activity will help you understand two of these laws.

Use the Solar System Database to draw histogram graphs on

Distance	(**Distance** with **Central Body** = Sun)
Orbital Period	(**Orbital Period** with **Central Body** = Sun)
Orbital Velocity	(**Orbital Velocity** with **Central Body** = Sun)

Obtain a print-out of or copy down each of the graphs.

What do the graphs on Distance and Orbital Velocity show? - (the relationship is the basis of Kepler's second law).

What do the graphs on Distance and Orbital Period show? - (the relationship is the basis of Kepler's third law).

Use diagrams to help explain your answers.

Check your answers against display sheet 23.

ACTIVITY 38 - Ptolemy and Copernicus

Ancient astronomers were handicapped by a lack of technology in their attempts to explain Earth's relationship to the Sun, planets and stars. This activity centres on the theories of two famous astronomers, Ptolemy and Copernicus (see display sheets 21 and 22 and the file **Astronomers**).

Write a story on the lives and influence of Ptolemy and Copernicus.

With the help of diagrams, describe their theories. Why do you think these theories survived for so long?

ACTIVITY 39 - Space Exploration

The space programs of both the United States of America and the USSR have seen failures at launch, after launch and in space.

Analyse the Space Exploration Database by **Year of Launch** with **Result equal to Failure.** Draw a Histogram graph of the results.

What does the graph and figures tell you about the failure rate and the space programs in general? Suggest reasons for the changes which occurred over time.

Use the database to find out how many fatalities have occurred in space. List those fatalities giving date, number, launch vehicle, destination and purpose.What are your views on the figures?

ACTIVITY 40 - Unmanned Exploration of the Moon

The United States of America and the USSR have sent numerous space probes to study the Moon and enhance man's knowledge of Earth's nearest celestial neighbour.

Analyse the Space Exploration Database, search the file **Exploration** and consult books in your school or local library to write a story on unmanned exploration of the Moon. Report on the successes, the failures, the discoveries and the value of these flights. Obtain pictures of the Moon's surface taken by one of these craft and include them in your report.

(Use **Destination = Moon and Crew = 0** to analyse the database and the Format utility to output the data by **Year of Launch, Country, Result** and **Spacecraft**).

ACTIVITY 41 - Manned Exploration of the Moon

The United States of America and the USSR competed in a "space race" to put the first man on the Moon. This "race" was "won" by the USA through its Apollo program.

Write a report on manned flight to the Moon. Include details on every flight, but cover in more detail man's first landing on the Moon's surface. Why do you think the USA won the "race" ?

What implications did this "space race" have in other areas such as the "arms race"? What has happened to spending on space in the past decade? (refer to display sheet 25).

Was the "race" to the Moon a waste of money? Give reasons for your answers.

(Use **Destination = Moon** and **Crew > 0** to analyse the database and the Format utility to output the data by **Year of Launch**, **Country**, **Result**, **Crew** and **Spacecraft**).

ACTIVITY 42 - Exploration of Jupiter

Limited exploration of the jovian or Jupiter-like planets has been undertaken by space probes launched by the United States of America. Details of these flights are contained in the Space Exploration Database in the field **Destination** (the field items are Jupiter, Jupiter Saturn and Jovian Planets). Details on the discoveries made by these craft may be obtained from the files section on Disk 1 and from books in your school or local library.

Search the database for launch data on the probes. Write a report on each flight giving launch details, the purpose, the achievements and the fate of the spacecraft. Give special emphasis to the discoveries made by each craft. Comment on the value of the space probes and their discoveries. Find drawings of the flight paths and include them in your report.

ACTIVITY 43 - Exploration of Venus and Mars

The exploration of the planets has been limited in the main to Earth's nearest neighbours. Analyse the Space Exploration Database to prove or disprove this statement.

Is the statement true? Use figures to justify your answer and, in the case of the statement being true, explain why you think space exploration has been so limited.

What do the figures appear to show about the space exploration strategies of the USA and the USSR in relation to Venus and Mars?

ACTIVITY 44 - Exploration of Venus

Both the United States of America and the USSR have sent space probes to Venus and Mars. Report on the activities, both successes and failures, of the USA and the USSR in relation to the exploration of Venus. Do two analyses on the Space Exploration Database as follows (obtain printouts of each analysis)

by **Country**

(1) with **Destination = Venus**

(2) with **Destination = Venus and Result = Failed**

by **Year of Launch**

(1) with **Destination = Venus and (Purpose = Fly-By or Purpose = Impact)**

(2) with **Destination = Venus and (Purpose = Orbit or (Purpose = Orbit/Land or Purpose = Land)**

What do the figures show about the Venus exploration programs of the USA and the USSR? Compare the determination of these countries in the exploration of this planet. In what way did available technology limit their objectives, particularly in the early launches?

ACTIVITY 45 - Exploration of Mars

Both the United States of America and the USSR have sent space probes to Venus and Mars. Report on the activities, both successes and failures, of the USA and the USSR in relation to the exploration of Mars. Do two analyses on the Space Exploration Database as follows (obtain printouts of each analysis)

by **Country**

(1) with **Destination = Mars**

(2) with **Destination = Mars and Result = Failed**

by **Year of Launch**

(1) with **Destination = Mars and (Purpose = Fly-By or Purpose = Impact)**

(2) with **Destination = Mars and (Purpose = Orbit or (Purpose = Orbit/Land or Purpose = Land)**

What do the figures show about the Mars exploration programs of the USA and the USSR? Compare the determination of these countries in the exploration of this planet. In what way did available technology limit their objectives, particularly in the early launches?

ACTIVITY 46 - Space Shuttle

We often forget or fail to acknowledge the advances that have been made in space technology in the past 30 years. These advances are reflected in spacecraft technology as well as onground support systems.

Part of this activity involves two analyses of the Space Exploration Database on the changes that occurred over time in crew size on manned flights. Search the database by **Year of Launch** with **Crew > 3.** Obtain a printout of the results. Do another search on the same field, but this time with **Crew > 0 and Crew <= 3** (we only want details on manned flights). Again obtain a printout of the results.

What do the figures show about the changes that have occurred in crew sizes? What do they show in terms of spacecraft technology?

The Space Shuttle is now seen as the "jumbo" of space vehicles. Describe the shuttle using drawings and technical data where appropriate. What happened to one of them in January, 1986? Why?

DATA and DISPLAY

SHEETS

THE PLANETS

PLANET	DIAMETER	ROTATION PERIOD	DENSITY	SURFACE GRAVITY	ESCAPE VELOCITY
Mercury	4,878	58.65 days	5.42	3.78	4.3
Venus	12,104	243.01 days	5.25	8.60	10.3
Earth	12,756	23 hrs 56 mts 4 secs	5.52	9.78	11.2
Mars	6,794	24 hrs 37 mts 23 secs	3.94	3.72	5.0
Jupiter	142,800	9 hrs 55 mts	1.31	22.88	59.5
Saturn	120,000	10 hrs 14 mts	0.69	9.05	35.6
Uranus	52,400	16 hrs 48 mts	1.19	7.77	21.2
Neptune	49,500	16 hrs	1.66	11.00	23.6
Pluto	3,000	6 days 9 hrs 18 mts	0.90	0.40	1.1

Diameter is in kilometres
Density is in grams per cubic centimetre
Surface Gravity is in metres per sec per second
Escape Velocity is in kilometres per second

PLANET	AXIS TILT	ORBITAL PERIOD	ORBITAL VELOCITY	INCLINATION
Mercury	0 deg	87.97 days	47.89	7.00
Venus	178 deg	224.70 days	35.03	3.39
Earth	23 deg 27'	365.26 days	29.79	0.00
Mars	23 deg 59'	686.98 days	24.13	1.85
Jupiter	3 deg 5'	11.86 years	13.06	1.30
Saturn	27 deg	29.46 years	9.64	2.49
Uranus	98 deg	84.01 years	6.81	0.77
Neptune	28 deg 48'	164.79 years	5.43	1.77
Pluto	>50 deg	247.70 years	4.74	17.20

Orbital Velocity is in kilometres per second
Inclination is in degrees

PLANET	MAXIMUM DISTANCE	MINIMUM DISTANCE	MEAN DISTANCE	ECCENTRICITY
Mercury	69.7	45.9	57.9	0.206
Venus	109.0	107.4	108.2	0.007
Earth	152.1	147.1	149.6	0.017
Mars	249.1	206.7	227.9	0.093
Jupiter	815.7	740.9	778.3	0.048
Saturn	1,507	1,347	1,427	0.055
Uranus	3,004	2,735	2,870	0.047
Neptune	4,537	4,456	4,497	0.008
Pluto	7,375	4,425	5,900	0.249

Distance from the Sun is in millions of kilometres

SATELLITES

PLANET: EARTH

SATELLITE	MEAN DISTANCE	DIAMETER	ORBITAL PERIOD	ECCENTRICITY	INCLINATION
Moon	384,400	3,476	27.32	0.055	5.14

Distance is in kilometres
Orbital Period is in days
Diameter is in kilometres
Inclination is in degrees

PLANET: MARS

SATELLITE	MEAN DISTANCE	DIAMETER	ORBITAL PERIOD	ECCENTRICITY	INCLINATION
Phobos	9,380	22	0.32	0.018	1.00
Deimos	23,500	12	1.26	0.002	2.00

Distance is in kilometres
Orbital Period is in days
Diameter is in kilometres
Inclination is in degrees

PLANET: JUPITER

SATELLITE	MEAN DISTANCE	DIAMETER	ORBITAL PERIOD	ECCENTRICITY	INCLINATION
Metis	128,000	40	0.29	0.000	0.00
Adrastea	129,000	25	0.30	0.000	0.00
Amalthea	181,300	210	0.49	0.003	0.45
Thebe	221,900	100	0.67	0.013	0.90
Io	421,600	3,630	1.77	0.000	0.03
Europa	670,900	3,138	3.55	0.000	0.47
Ganymede	1,070,000	5,262	7.15	0.001	0.18
Callisto	1,880,000	4,800	16.69	0.007	0.25
Leda	11,094,000	10	239.60	0.147	27.00
Himalia	11,480,000	180	250.60	0.158	28.00
Lysithea	11,720,000	25	259.20	0.120	29.00
Elara	11,737,000	80	259.70	0.207	26.00
Ananke	21,200,000	25	631.00	0.169	147.00
Carme	22,600,000	30	692.00	0.207	163.00
Pasiphae	23,500,000	40	735.00	0.400	147.00
Sinope	23,700,000	30	758.00	0.275	156.00

Distance is in kilometres
Orbital Period is in days
Diameter is in kilometres
Inclination is in degrees

PLANET: SATURN

SATELLITE	MEAN DISTANCE	DIAMETER	ORBITAL PERIOD	ECCENTRICITY	INCLINATION
Atlas	137,700	30	0.60	0.002	0.30
1980 S27	139,350	100	0.61	0.004	0.00
1980 S26	141,700	90	0.63	0.004	0.10
Janus	151,420	120	0.69	0.007	0.10
Epimetheus	151,470	120	0.69	0.009	0.30
Mimas	185,500	392	0.94	0.020	1.52
Enceladus	238,000	500	1.37	0.004	0.02
Tethys	294,700	1,060	1.89	0.000	1.09
Telesto	294,700	30	1.89		
Calypso	294,700	25	1.89		
1980 S34	330,000	18			
1981 S10	330,000	18			
1981 S11	350,000	18			
Dione	377,400	1,120	2.74	0.002	0.02
Dione B	377,400	35	2.74	0.005	0.20
1981 S7	380,000	18			
1981 S8	380,000	18			
1981 S9	470,000	18			
Rhea	527,000	1,530	4.52	0.001	0.35
Titan	1,221,900	5,150	15.95	0.029	0.33
Hyperion	1,481,000	300	21.28	0.104	0.40
Iapetus	3,561,000	1,460	79.33	0.028	14.70
Phoebe	12,954,000	220	550.40	0.163	150.00

Distance is in kilometres
Orbital Period is in days
Diameter is in kilometres
Inclination is in degrees

PLANET: URANUS

SATELLITE	MEAN DISTANCE	DIAMETER	ORBITAL PERIOD	ECCENTRICITY	INCLINATION
Miranda	130,500	490	1.41	0.017	3.4
Ariel	191,800	1,300	2.52	0.003	0.0
Umbriel	267,200	1,200	4.14	0.004	0.0
Titania	438,000	1,600	8.71	0.002	0.0
Oberon	586,300	1,600	13.46	0.001	0.0
1985 U1		165			
1986 U1		40			
1986 U2		40			
1986 U3		40			
1986 U4		40			
1986 U5		40			
1986 U6		40			
1986 U7		15			
1986 U8		15			
1986 U9		50			

Distance is in kilometres
Diameter is in kilometres
Orbital Period is in days
Inclination is in degrees

PLANET: NEPTUNE

SATELLITE	MEAN DISTANCE	DIAMETER	ORBITAL PERIOD	ECCENTRICITY	INCLINATION
Triton	353,000	3,500	5.88	0.000	160.0
Nereid	5,560,000	300	365.21	0.750	28.0

Distance is in kilometres
Orbital Period is in days
Diameter is in kilometres
Inclination is in degrees

PLANET: PLUTO

SATELLITE	MEAN DISTANCE	DIAMETER	ORBITAL PERIOD	ECCENTRICITY	INCLINATION
Charon	19,000	1,200	6.39	0.000	94.0

Distance is in kilometres
Orbital Period is in days
Diameter is in kilometres
Inclination is in degrees

THE MOON

Diameter	3,476 km
Rotation Period	27.32 days
Density	3.34 gm/c.c.
Surface Gravity	1.62 m/sec/sec
Escape Velocity	2.38 km/sec
Axis Tilt	6.5 degrees
Orbital Period	27.32 days
Orbital Velocity	10.10 km /sec
Inclination	5.14 degrees
Eccentricity	0.055
Maximum distance	406,700 km
Minimum distance	356,400 km
Mean Distance	384,400 km

IMPORTANT ASTEROIDS

ASTEROID	DIAMETER	ROTATION PERIOD	ORBITAL PERIOD	INCLINATION	ECCENTRICITY
Ceres	1003	9.078	4.06	10.6	0.079
Pallas	608	7.811	4.61	34.8	0.237
Juno	250	7.210	4.36	13.0	0.257
Vesta	538	5.342	3.63	7.1	0.088
Hebe	195	7.275	3.78	14.8	0.203
Iris	209	7.135	3.68	5.5	0.230
Hygiea	450	?	5.59	3.8	0.099
Eunomia	272	6.082	4.30	11.7	0.188
Psyche	250	4.303	5.00	3.1	0.135
Eros	29x14	5.270	1.76	10.8	0.223
Davida	323	5.167	5.70	15.7	0.166
Icarus	1	2.273	1.12	23.0	0.827
Apollo	3	3.063	1.78	6.4	0.566

Diameter is in kilometres
Orbital Period is in years
Rotation Period is in hours
Inclination is in degrees

ASTEROID	MEAN DISTANCE	YEAR DISCOVERED	DISCOVERER
Ceres	413.8	1801	G. Piazzi
Pallas	414.1	1802	H. Olbers
Juno	399.1	1804	K. Harding
Vesta	353.4	1807	H. Olbers
Hebe	362.9	1847	K. Hencke
Iris	356.9	1847	J. Hind
Hygiea	471.4	1849	A. de Gasparis
Eunomia	395.4	1851	A. de Gasparis
Psyche	437.3	1851	A. de Gasparis
Eros	218.1	1898	G. Witt
Davida	477.2	1903	R. Dugan
Icarus	161.3	1949	W. Baade
Apollo	222.3	1932	K. Reinmuth

Mean distance is in million of kilometres

DISPLAY SHEETS INDEX

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Earth's Magnetic Field	Dipole Field, Magnetosphere	2
Eclipses	Moon's Orbit, Lunar Eclipse, Solar Eclipses	3
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Observing the Planets	Inferior Planets, Superior Planets	20
Ocean Tides	Why tides occur	4
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Phases of the Moon	From New Moon to Full Moon	7
Ptolemy	The Ptolemaic System	21
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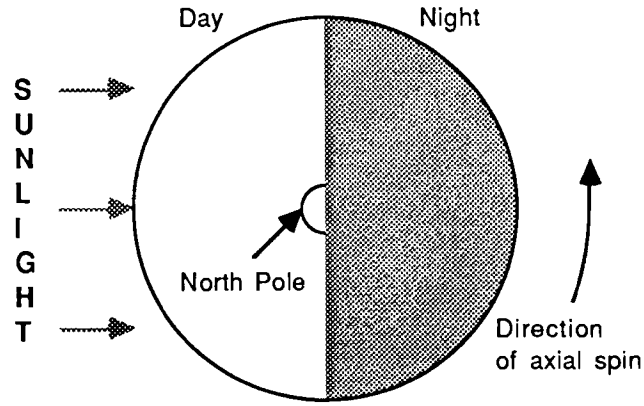
The Moon	Mass, Structure, Position	6
The Seasons	Earth's Seasons	5
The Sun	Structure, Poles, Path across the Sky	8
U.S. Space Budget	Spending on Space programs	25

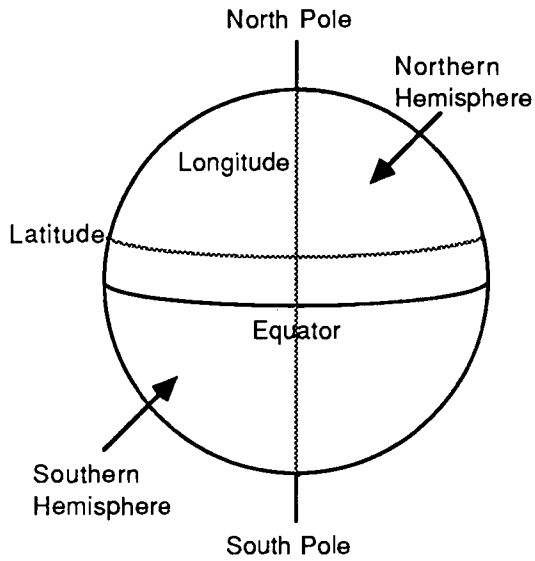
EARTH



DAY AND NIGHT

The Earth spins on its axis in an eastward direction. This is why the Sun appears to rise in the east and set in the west.

This diagram shows the Earth from above the North Pole. It is day for the side in sunlight and night for the side hidden from the Sun by the Earth itself. Our planet spins in an eastward direction and takes about 24 hours to complete one orbit around its axis.



THE EQUATOR, LATITUDE AND LONGITUDE

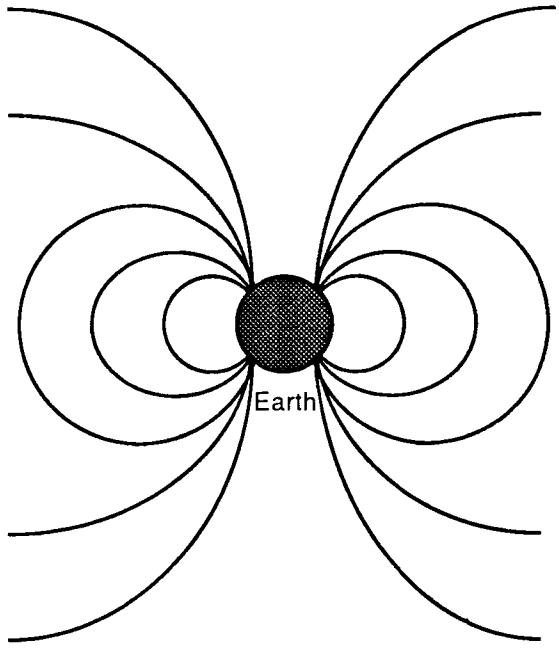
The equator is an imaginary line around the Earth between the two poles. It divides the Earth into two halves called hemispheres.

The surface is divided into 360 parts by imaginary lines drawn between the poles. The position of any place east or west of the line that crosses Greenwich, England is called its longitude.

The position of any place north or south of the equator is called its latitude.

Note: The Earth's poles are shown as straight up and down to help in the explanation of the above concepts. The Earth's axis is in fact tilted at 23.5 degrees to the vertical.

EARTH'S MAGNETIC FIELD

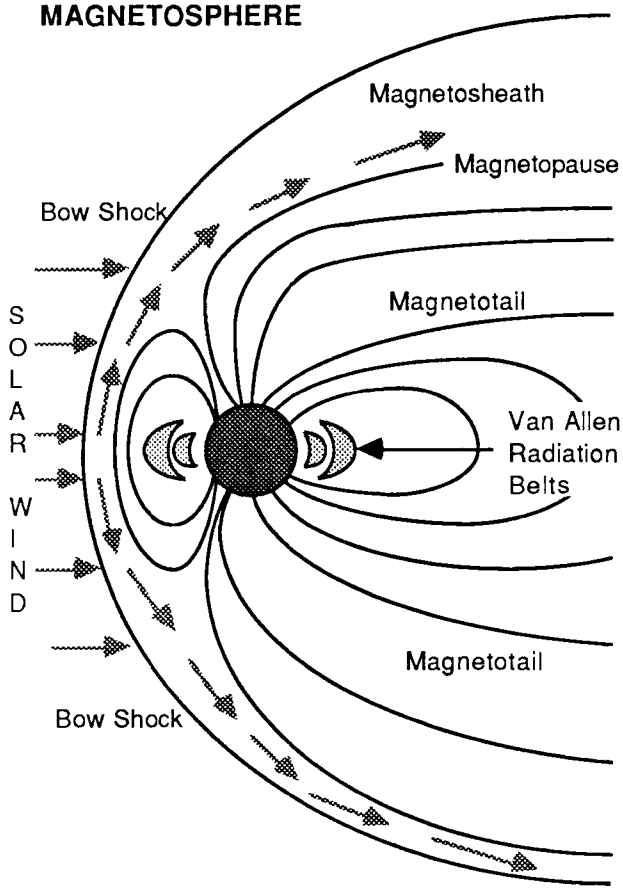


DIPOLE FIELD

This diagram shows what Earth's magnetic field would look like if it was a perfect dipole field not influenced by the solar wind.

The following diagram shows Earth's actual magnetic field and its shape after interaction with the solar wind.

MAGNETOSPHERE



ACTUAL MAGNETIC FIELD

The solar wind interacts with Earth's magnetic field creating a magnetosphere where particles in the wind are controlled.

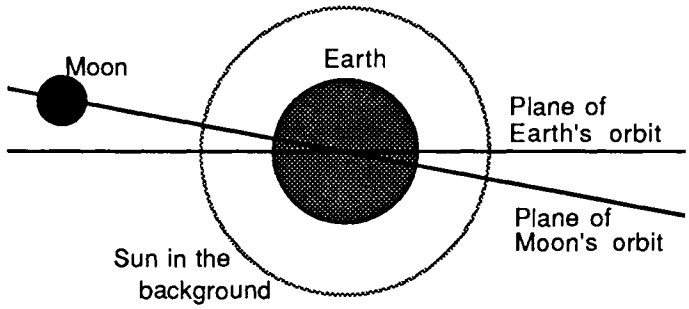
The magnetic field is distorted by the solar wind. The field appears comet-shaped with a tail (magnetotail) pointing away from the Sun.

The solar wind blows around the field's outer boundary, called the magnetopause.

A bow shock is formed in front of the magnetosphere where the solar wind first senses Earth's magnetic field.

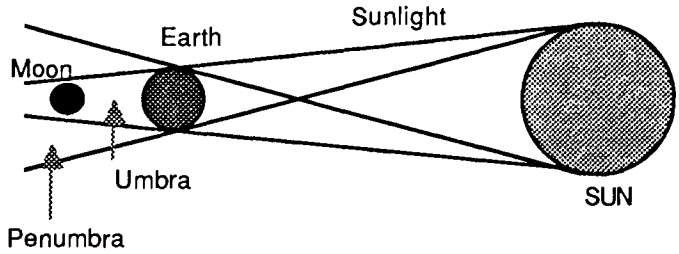
The area between the bow shock and the magnetopause is called the magnetosheath.

ECLIPSES



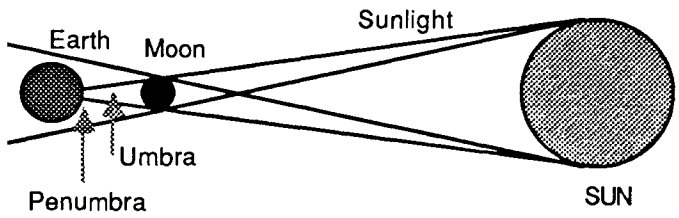
MOON'S ORBIT

The plane of the Moon's orbit is inclined at five degrees to the Earth-Sun orbital plane. Because of this, eclipses don't occur every month.



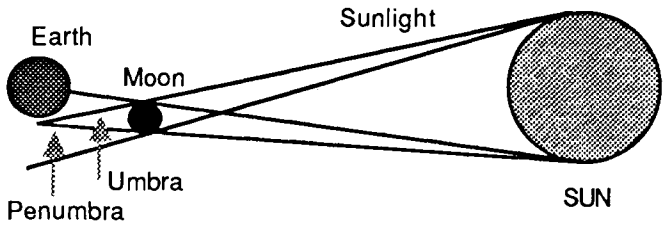
LUNAR ECLIPSE

A Lunar Eclipse occurs when the Moon passes through the Earth's shadow.



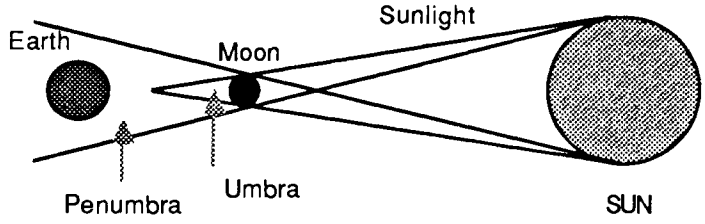
TOTAL SOLAR ECLIPSE

A Total Eclipse occurs when the Moon is between the Sun and Earth and the Moon's central shadow (the umbra) reaches Earth.



PARTIAL SOLAR ECLIPSE

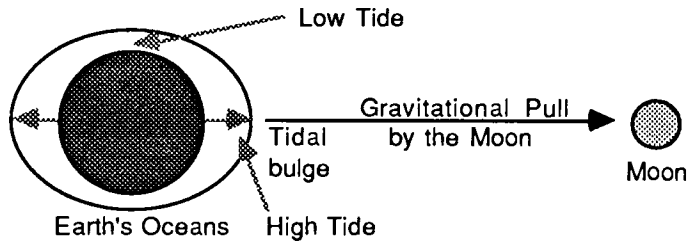
A Partial Eclipse occurs when only part of the Moon's shadow (the penumbra) reaches Earth and the umbra points away from Earth.



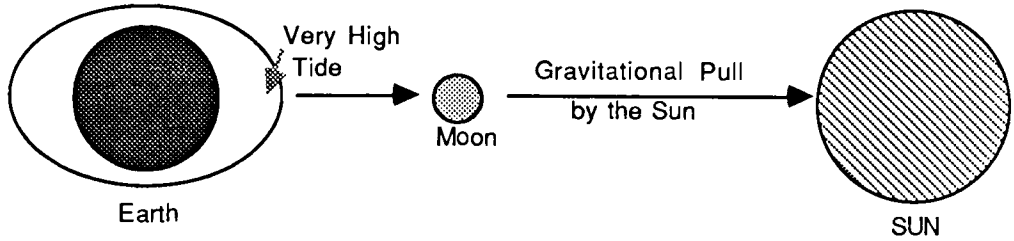
ANNULAR SOLAR ECLIPSE

An Annular Eclipse occurs when the Moon is between the Earth and the Sun and when the Moon is too far away from Earth for its central shadow (the umbra) to reach the surface.

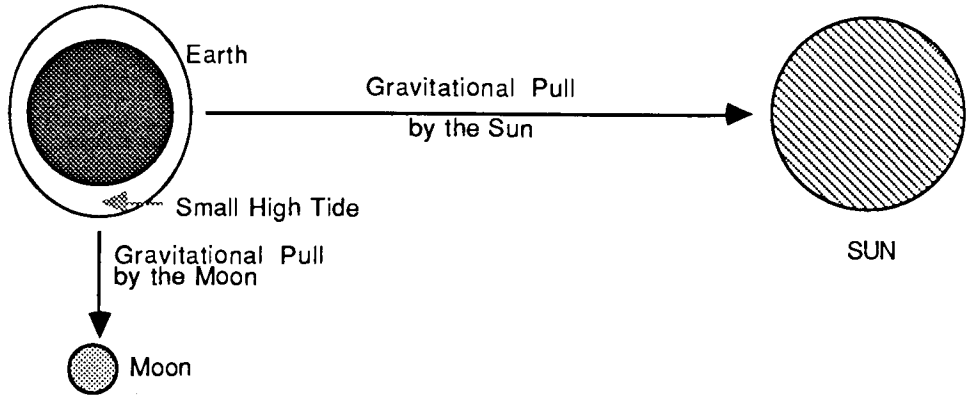
OCEAN TIDES



The gravitational pulls of the Moon and the Sun affect the Earth's oceans causing tides. Because the tidal pull of the Sun is less than half that of the Moon, tidal bulges (high tides) occur in the oceans beneath the Moon and on the direct opposite side of the Earth. Two high tides and two low tides occur every 24 hours 50 minutes.



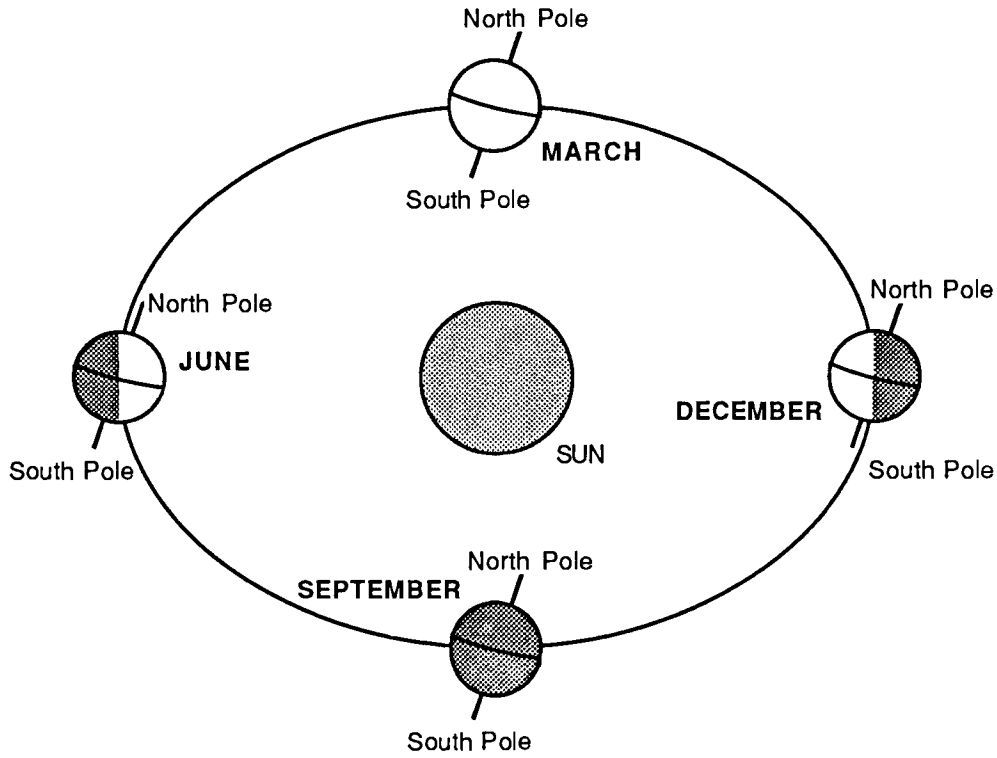
At Full Moon and at New Moon, the combined pulls of the Sun and the Moon produce very high tides called spring tides. These tides are exceptionally high when the Moon is close to perigee and the Earth is close to perihelion.

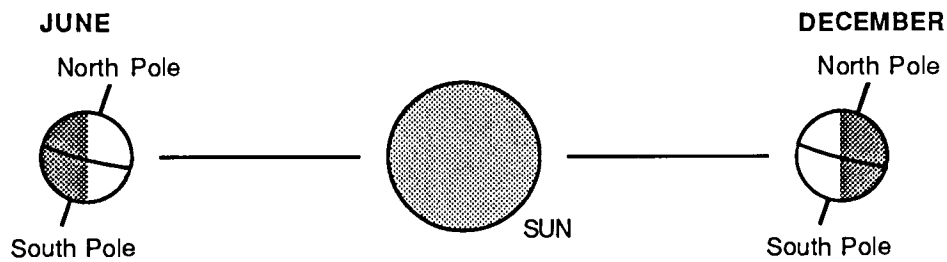


When the Moon is at quadrature, the Sun's gravitational pull counters in part the pull of the Moon. The lowest high tides (neap tides) occur at this point.

NOTE: Tides are distortions of a planet produced by the gravitational pull of another body. Tides are produced not only in Earth's oceans, but also in the atmosphere and the interior.

THE SEASONS

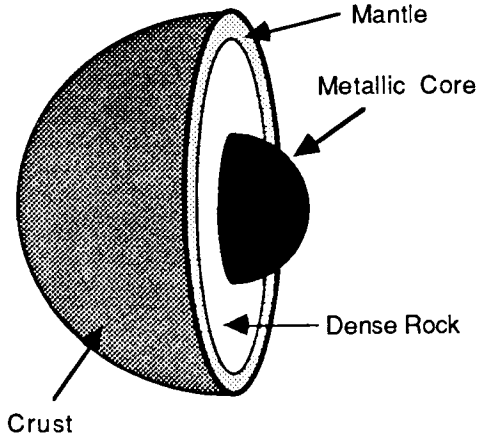




If the Earth's axis was straight up and down, everywhere on the surface would get the same amount of sunlight each day, every day. There would be no seasons.

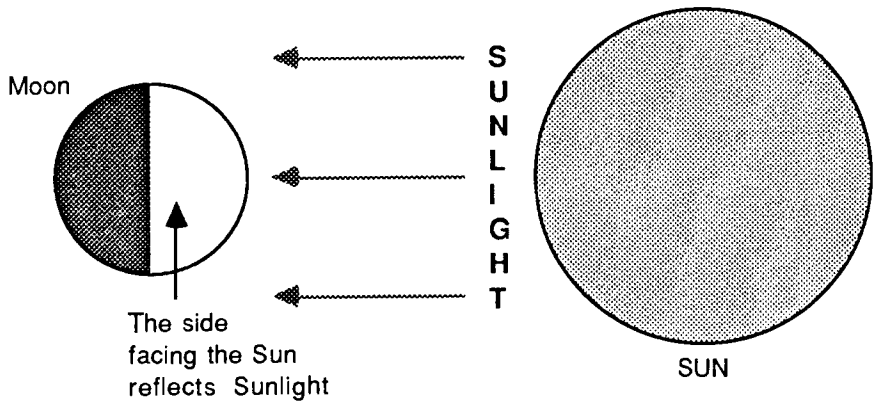
Because the Earth's axis is tilted 23.5 degrees, the planet experiences seasons as it orbits the Sun. In December, the North Pole tilts away from the Sun. It is winter in the Northern Hemisphere and summer in the Southern Hemisphere. In June, the North Pole tilts towards the Sun. It is summer in the Northern Hemisphere and winter in the Southern Hemisphere. In March and September, the Sun shines directly over the equator. Any area on Earth has equal day and night.

THE MOON

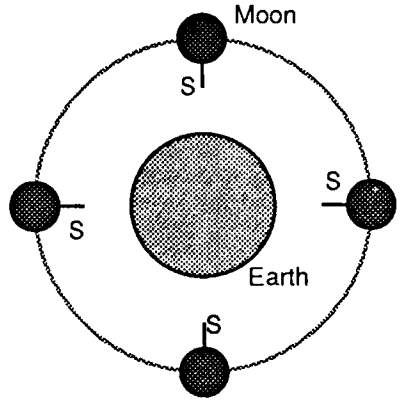


The surface of the Moon consists of rock and lunar dust. Under the outer surface is a layer of rock about 25km thick and under that, a layer of feldspar-rich rock about 35km thick.

The next layer is the mantle which is about 150km thick. Under the mantle is a layer of denser rock about 800km thick. The metallic core is from 1000 to 1500km in diameter.



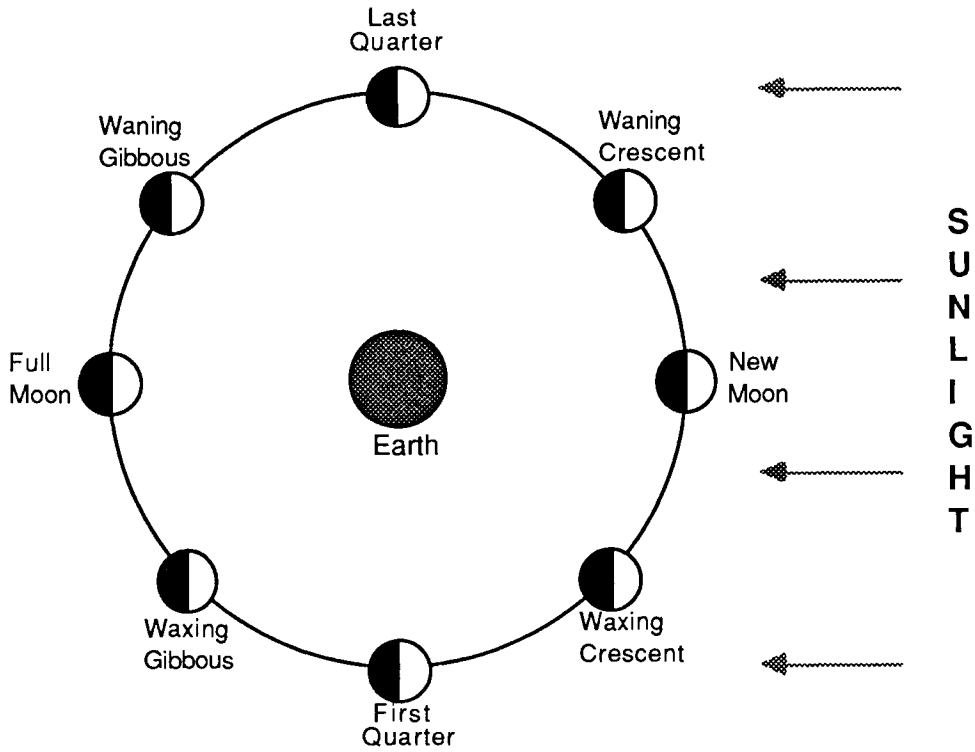
The Moon has no light of its own. It shines by reflecting sunlight.



The Moon's rotation period is the same as its orbital period. This causes the same side of the Moon (shown with an S) to permanently face Earth.

The far side of the Moon was unknown until 1959 when it was photographed by the space probe Luna 3.

PHASES OF THE MOON



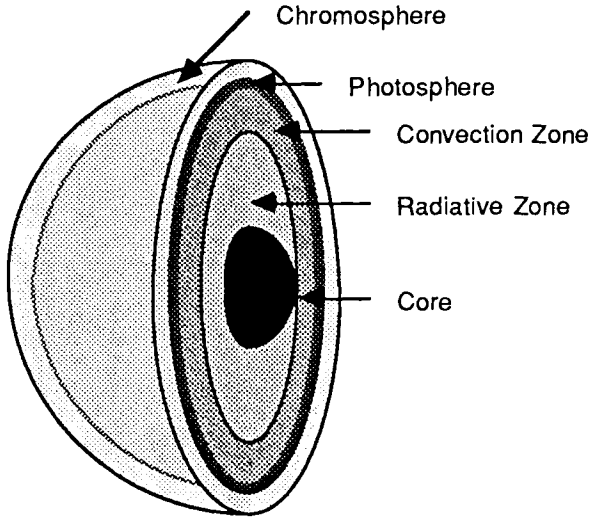
THE PHASES OF THE MOON AS SEEN FROM EARTH (SOUTHERN HEMISPHERE)

The Moon shines because it reflects sunlight. During its orbit of Earth, different parts of its surface are visible. These visible parts are called the phases of the Moon.

At New Moon, the Moon cannot be seen as its dark side is turned towards Earth and its bright side towards the Sun. After a few days, it appears in the evening sky as a thin crescent. At the end of the first week, its left half is visible. This phase is called the First Quarter. During the next week, more and more of its surface becomes visible as it passes through the Gibbous phase. At the end of the second week, it is a Full Moon with all its surface visible.

After the Full Moon, the phases occur in reverse order. At the end of the third week, its right half is visible at a phase called the Last Quarter. After that it becomes a thin crescent and after 29.5 days, a New Moon.

THE SUN

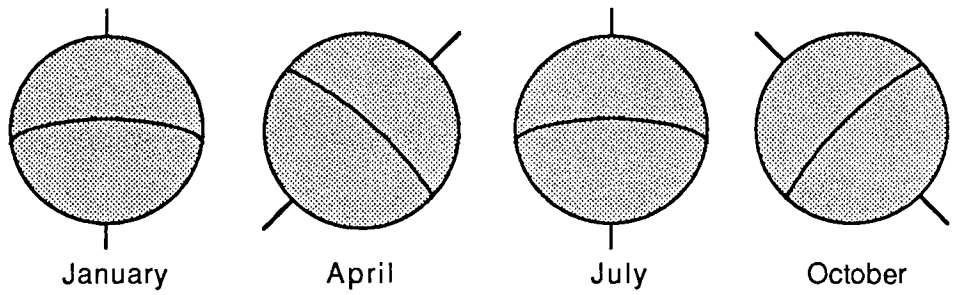


STRUCTURE

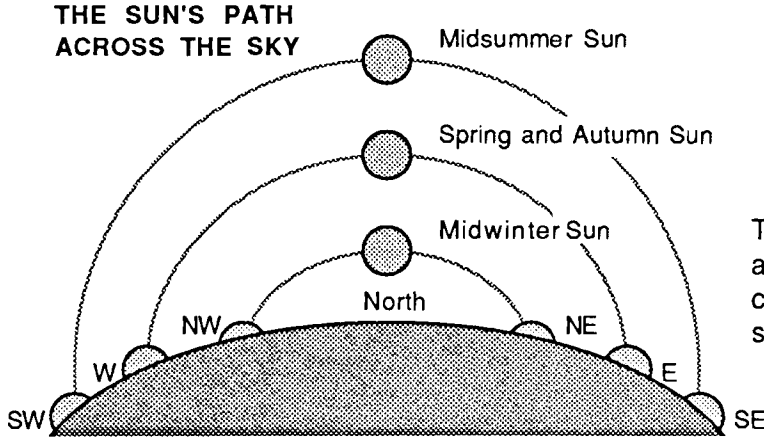
The Sun's energy comes from nuclear fusion at its core. The energy loss from this process rises to the surface where it radiates into space.

The surface of the Sun is called the Photosphere. The lower atmosphere is called the Chromosphere. The outer atmosphere is called the Corona.

POSITIONS OF THE SUN'S POLES AND EQUATOR

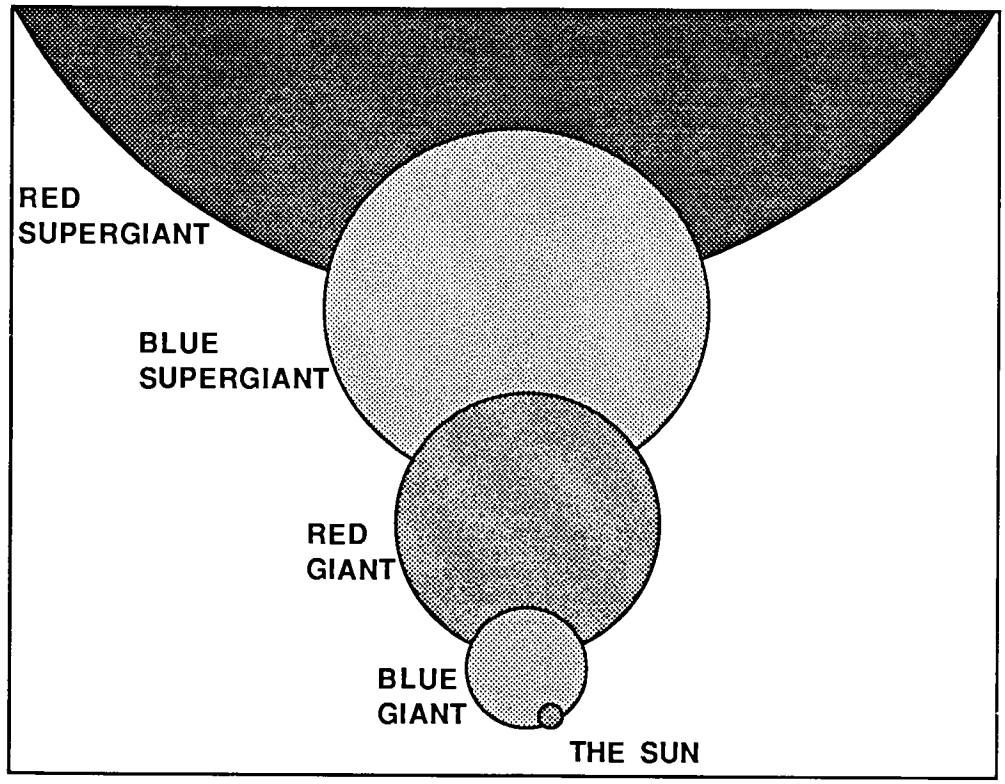


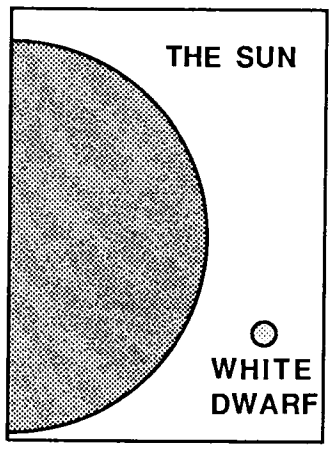
THE SUN'S PATH ACROSS THE SKY

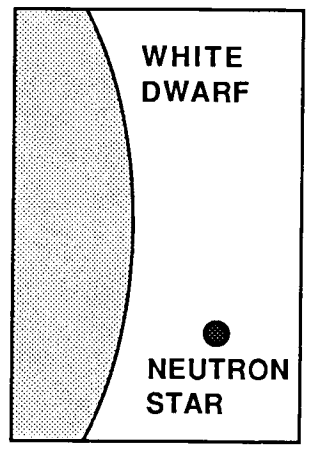


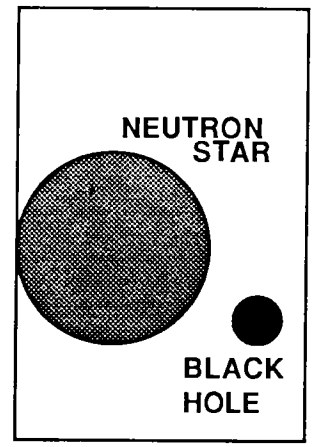
The Sun's daily path across the sky changes with the seasons of the year.

RELATIVE SIZES OF STARS







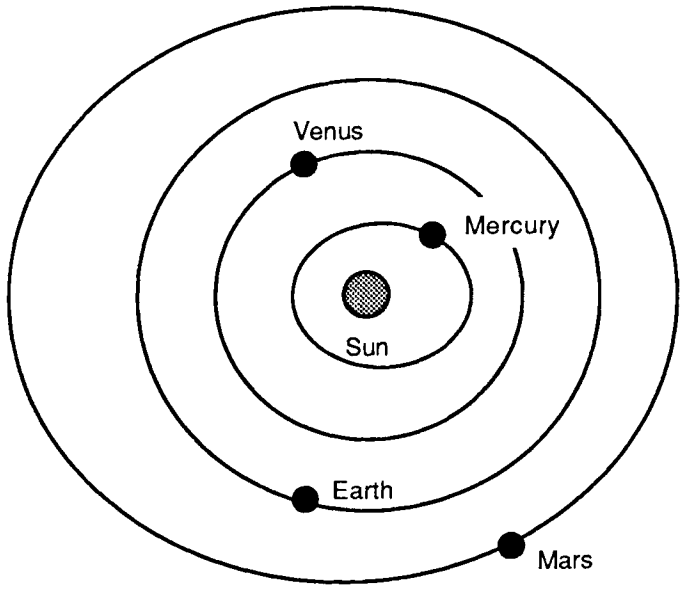


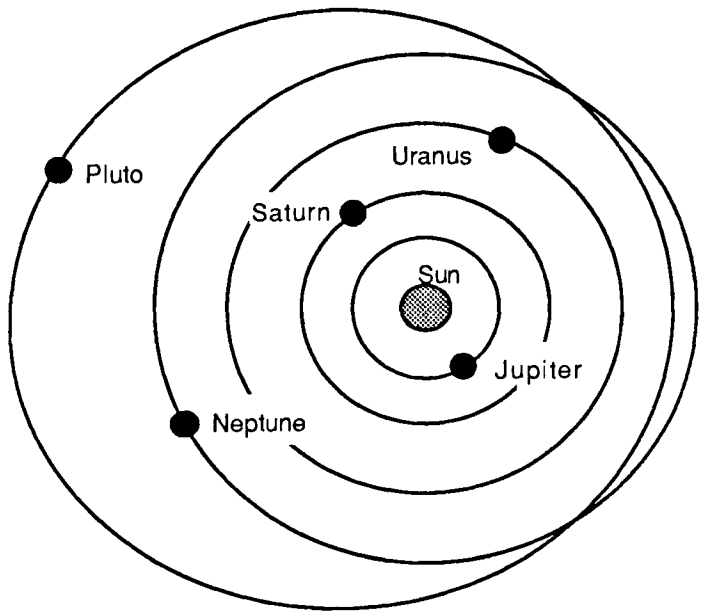
TYPES OF STARS

TYPE	O	B	A	F	G	K	M
COLOUR	Blue	Bluish White	White	Yellowish White	Yellow	Orange	Red
TEMP. C.	35,000	21,000	10,000	7,500	6,000	4,700	3,300

Stars are classified by colour. The hotter a star, the brighter it is.

ORBITS OF THE PLANETS





Eccentricity is the difference between an elliptical orbit and a circle.

All the planets revolve about the Sun in elliptical orbits.

Pluto's orbit is the most highly elliptical. At times, this small planet is closer to the Sun than Neptune.

Venus has the least elliptical orbit: it is almost circular.

Distance (million km)

Planet	Greatest	Least
Mercury	69.7	45.9
Venus	109.0	107.4
Earth	152.1	147.1
Mars	249.1	206.7
Jupiter	815.7	740.9
Saturn	1507	1347
Uranus	3004	2735
Neptune	4537	4456
Pluto	7375	4425

Eccentricity

Planet	Value
Mercury	0.206
Venus	0.007
Earth	0.017
Mars	0.093
Jupiter	0.048
Saturn	0.055
Uranus	0.047
Neptune	0.008
Pluto	0.249

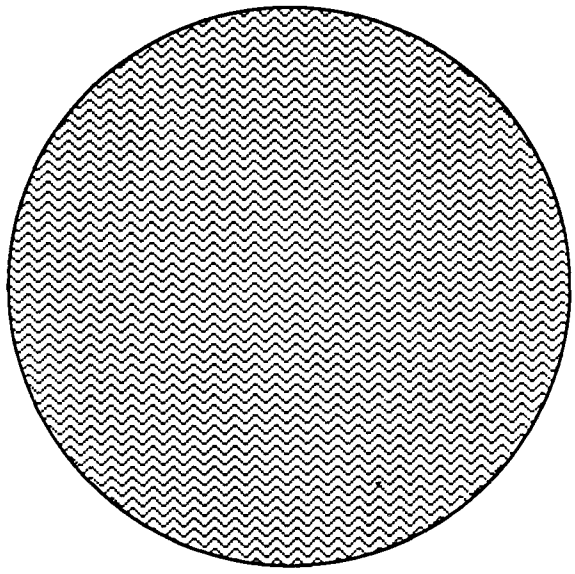
SIZES OF THE PLANETS

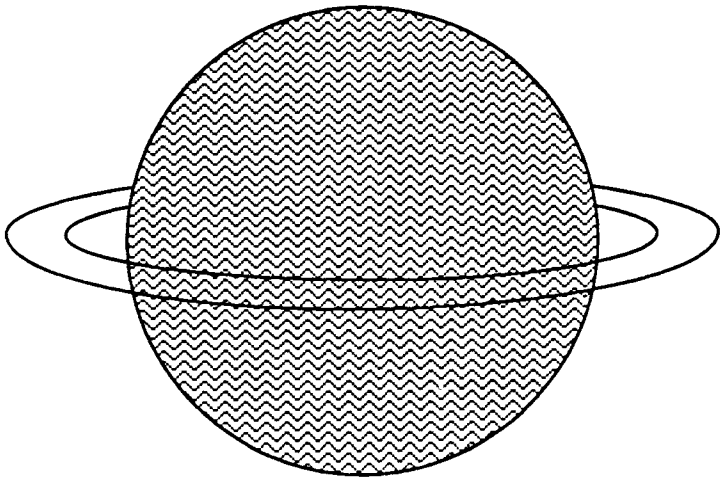

Mercury

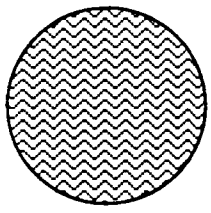

Venus

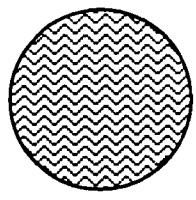

Earth


Mars


Jupiter


Saturn


Uranus


Neptune


Pluto

The planets are drawn to scale by diameter.

Size by Diameter (km)

Planet	Diameter
Mercury	4,878
Venus	12,104
Earth	12,756
Mars	6,794
Jupiter	142,800
Saturn	120,000
Uranus	52,400
Neptune	49,500
Pluto	3,000

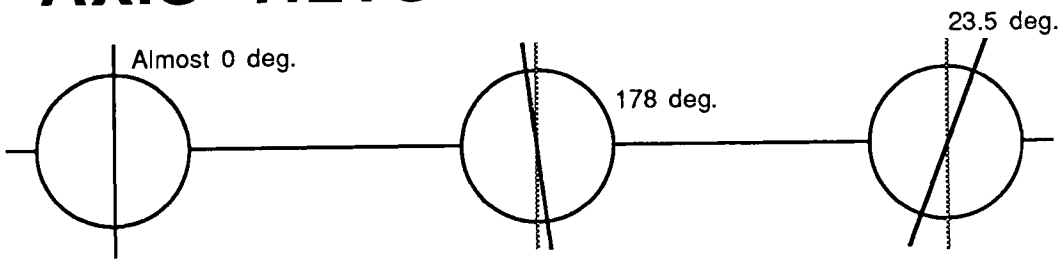
Relative Size by Volume

Planet	Volume
Mercury	0.06
Venus	0.88
Earth	1.00
Mars	0.15
Jupiter	1316
Saturn	755
Uranus	67
Neptune	57
Pluto	0.10

Relative Size by Mass

Planet	Mass
Mercury	0.055
Venus	0.815
Earth	1.000
Mars	0.107
Jupiter	317.99
Saturn	95.19
Uranus	14.56
Neptune	17.23
Pluto	0.002

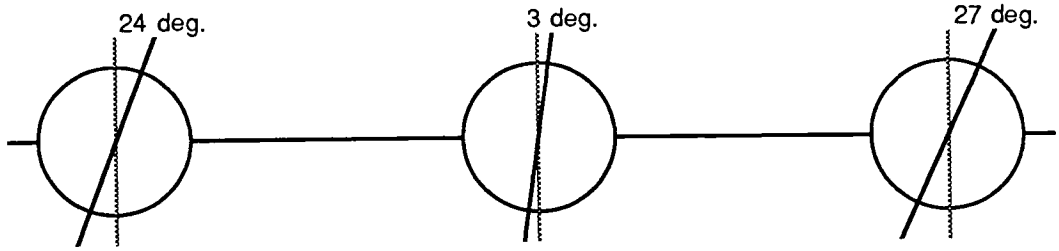
AXIS TILTS



Mercury
(Almost 0 deg.)

Venus
(178 deg.)

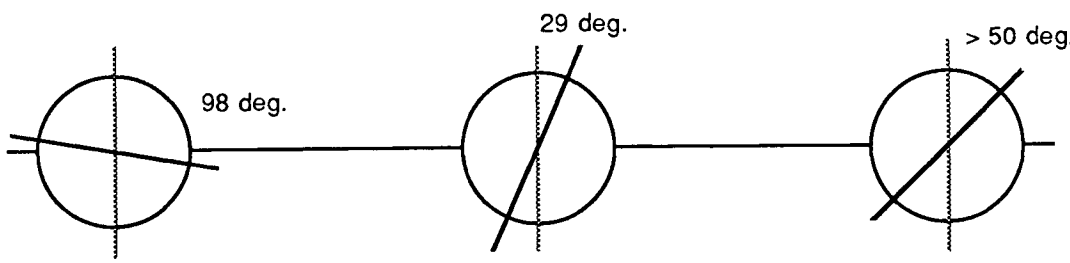
Earth
(23.5 deg.)



Mars
(24 deg.)

Jupiter
(3 deg.)

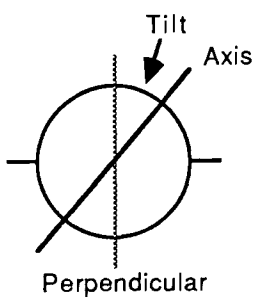
Saturn
(27 deg.)



Uranus
(98 deg.)

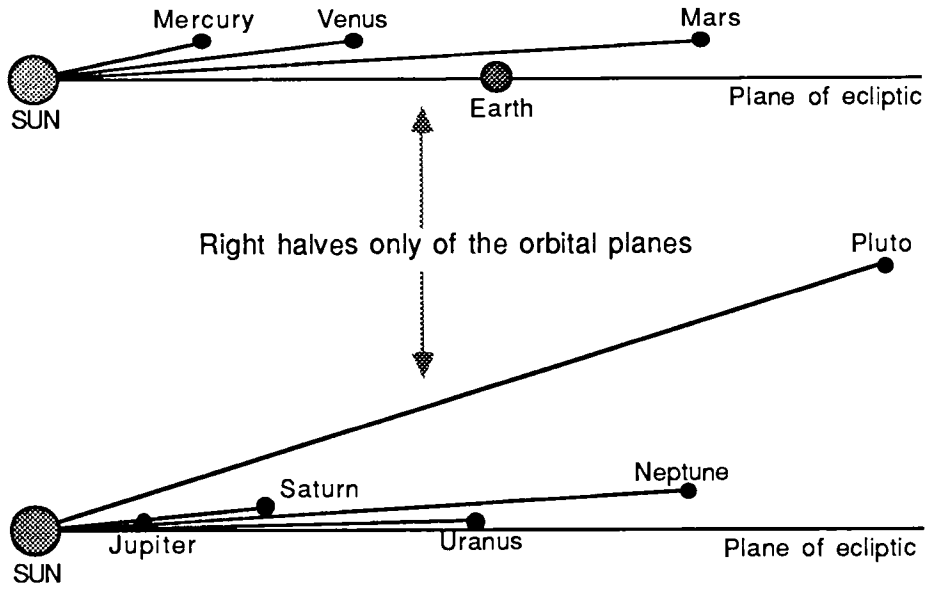
Neptune
(29 deg.)

Pluto
(> 50 deg.)



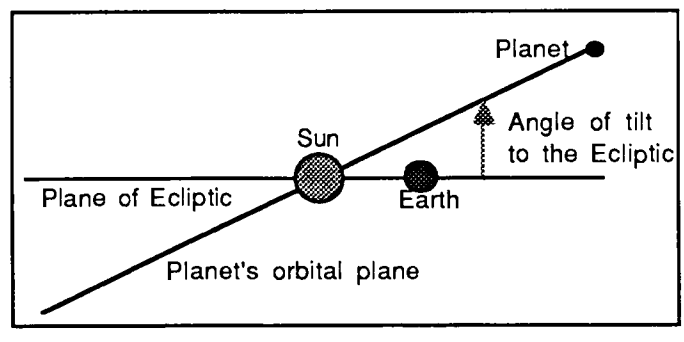
A planet's axis is an imaginary line around which the planet rotates. It is not perpendicular to the planet's orbit around the Sun. The degree of tilt from the perpendicular varies from planet to planet. The axis tilt for each planet is shown above.

ORBITAL PLANES

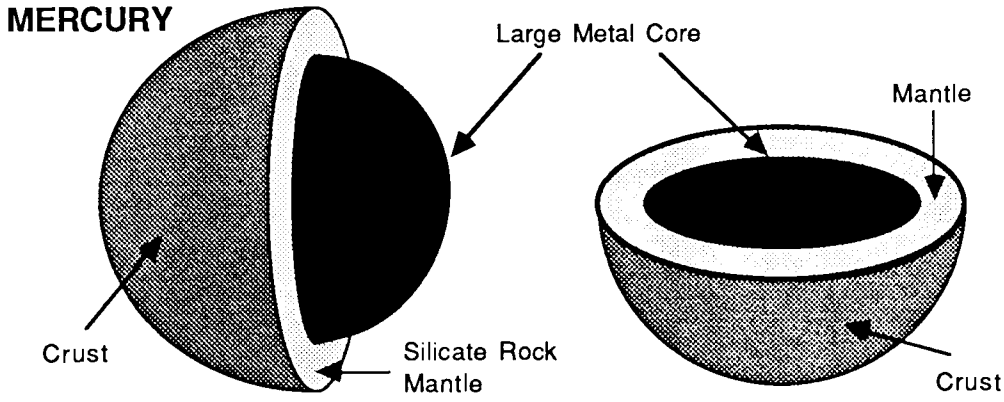


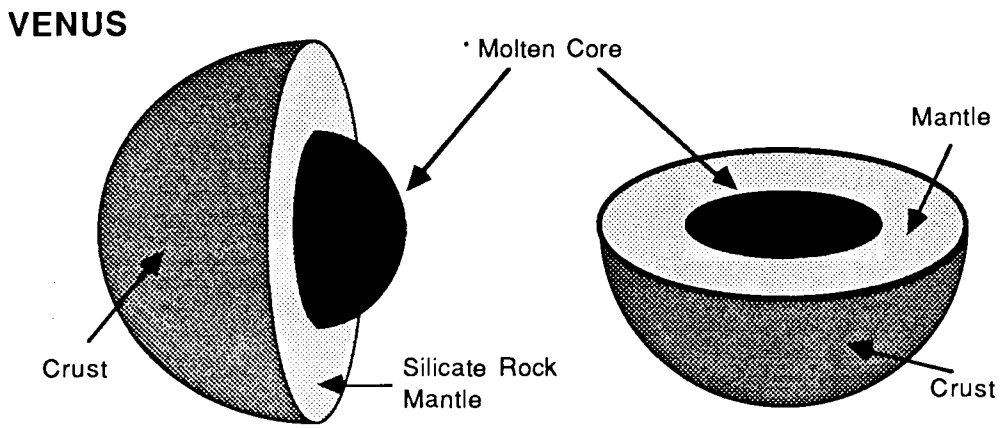
Each planet orbits the Sun in a plane different to those of the other planets. The Earth-Sun orbital plane, called the ecliptic, is used as the reference plane when describing the orbital planes of the other planets. The angle of tilt (or inclination) to the ecliptic varies from planet to planet. Pluto has the largest tilt of 17.20 degrees and Uranus the smallest of 0.77 degrees. The table below lists the tilts (in degrees) for all the planets.

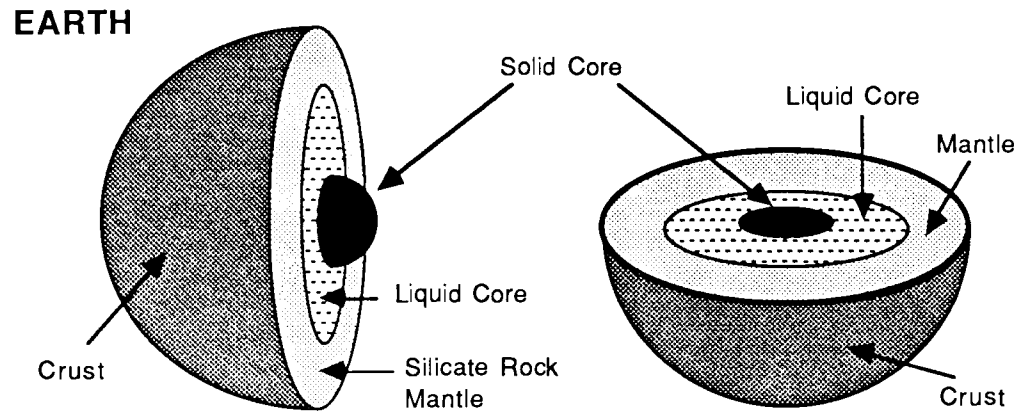
Planet	Tilt
Mercury	7.00
Venus	3.39
Earth	-
Mars	1.85
Jupiter	1.30
Saturn	2.49
Uranus	0.77
Neptune	1.77
Pluto	17.20



INTERNAL STRUCTURE - MERCURY VENUS EARTH

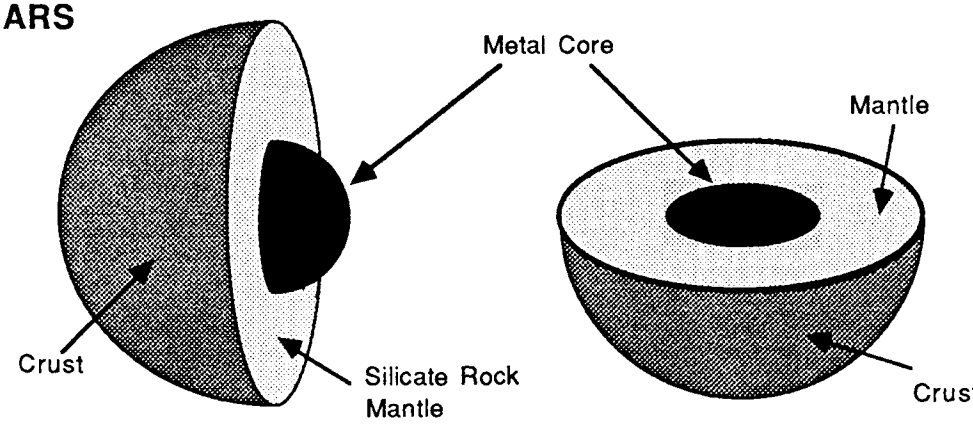




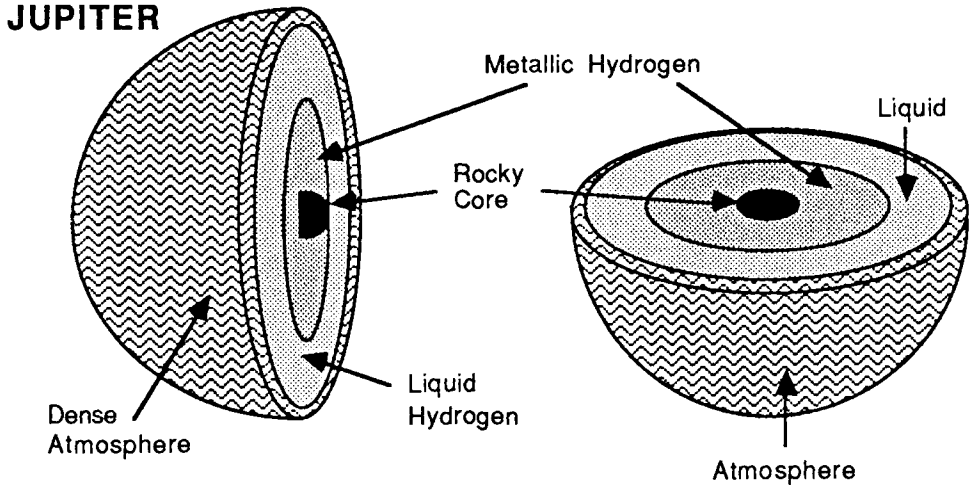


INTERNAL STRUCTURE - MARS JUPITER SATURN

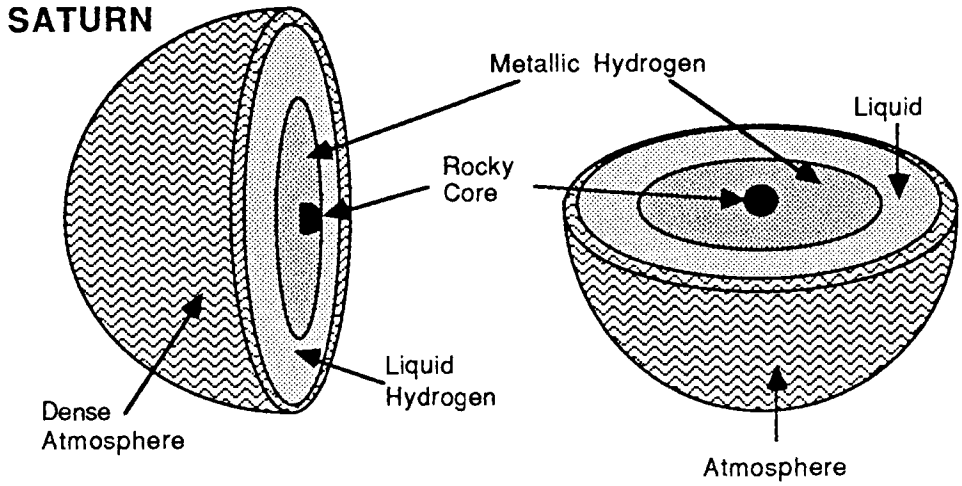
MARS



JUPITER

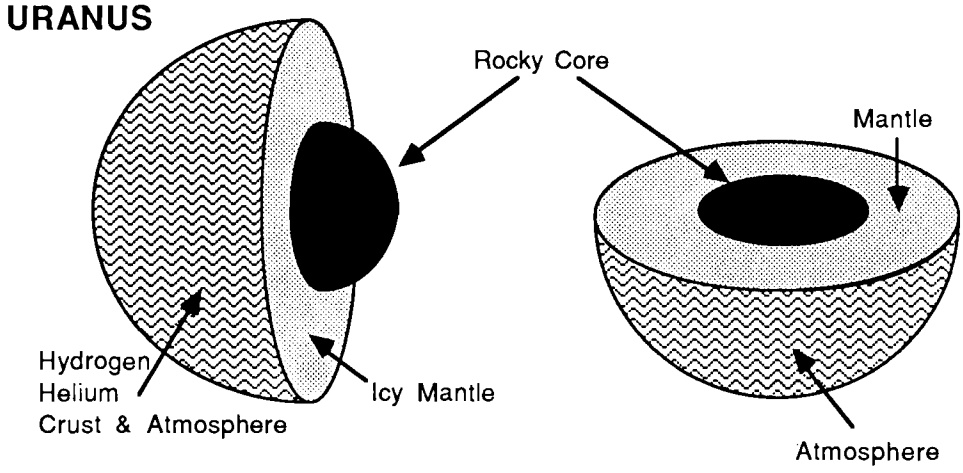


SATURN

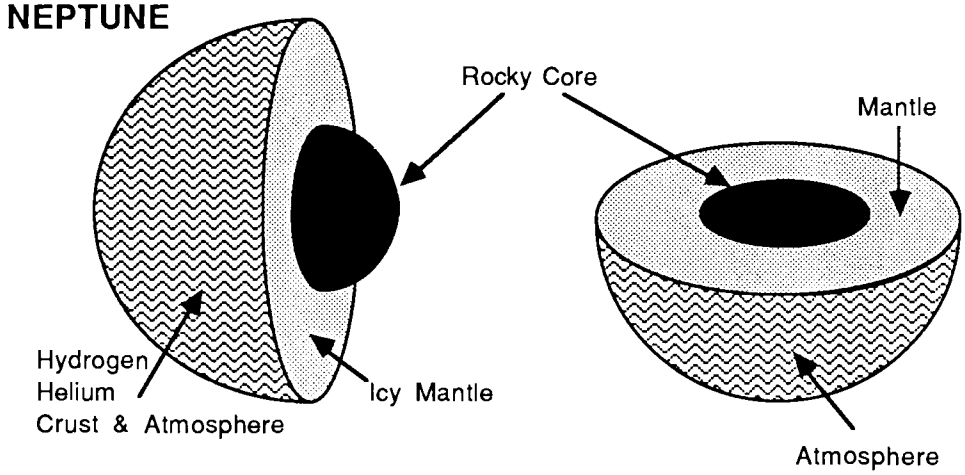


INTERNAL STRUCTURE - URANUS NEPTUNE PLUTO

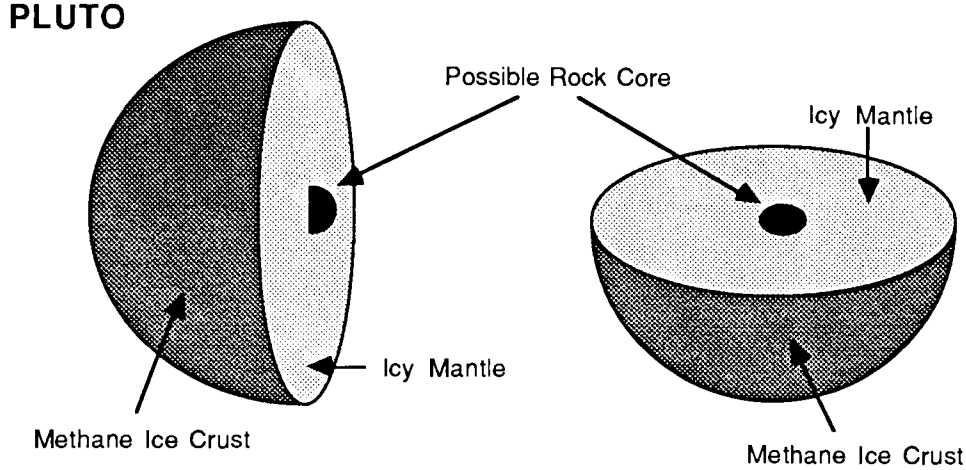
URANUS



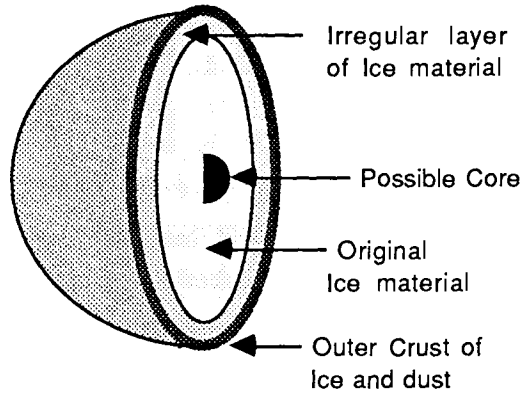
NEPTUNE



PLUTO

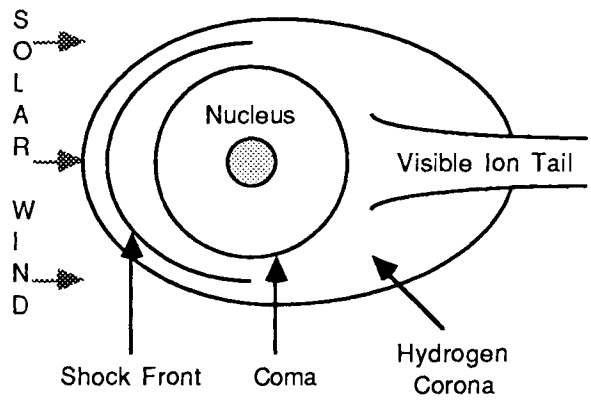


COMETS



ICY CONGLOMERATE MODEL

The Icy Conglomerate model of the nucleus envisages a core around which are several layers of ice. The outer crust consists of ice covered by a layer of dust.

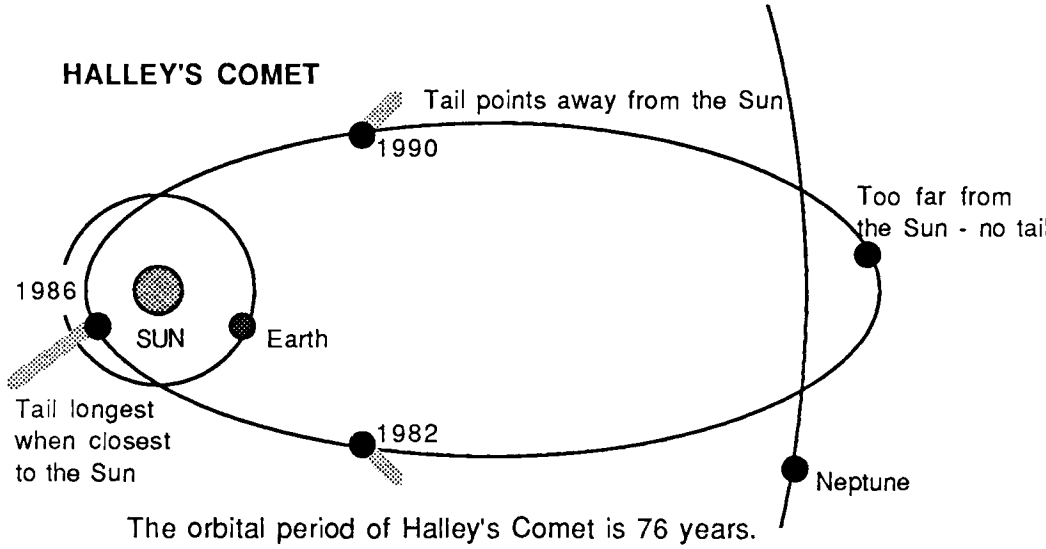


ANATOMY OF A COMET

A comet consists of a nucleus, a coma of gas and dust around the nucleus, a hydrogen cloud corona and tail.

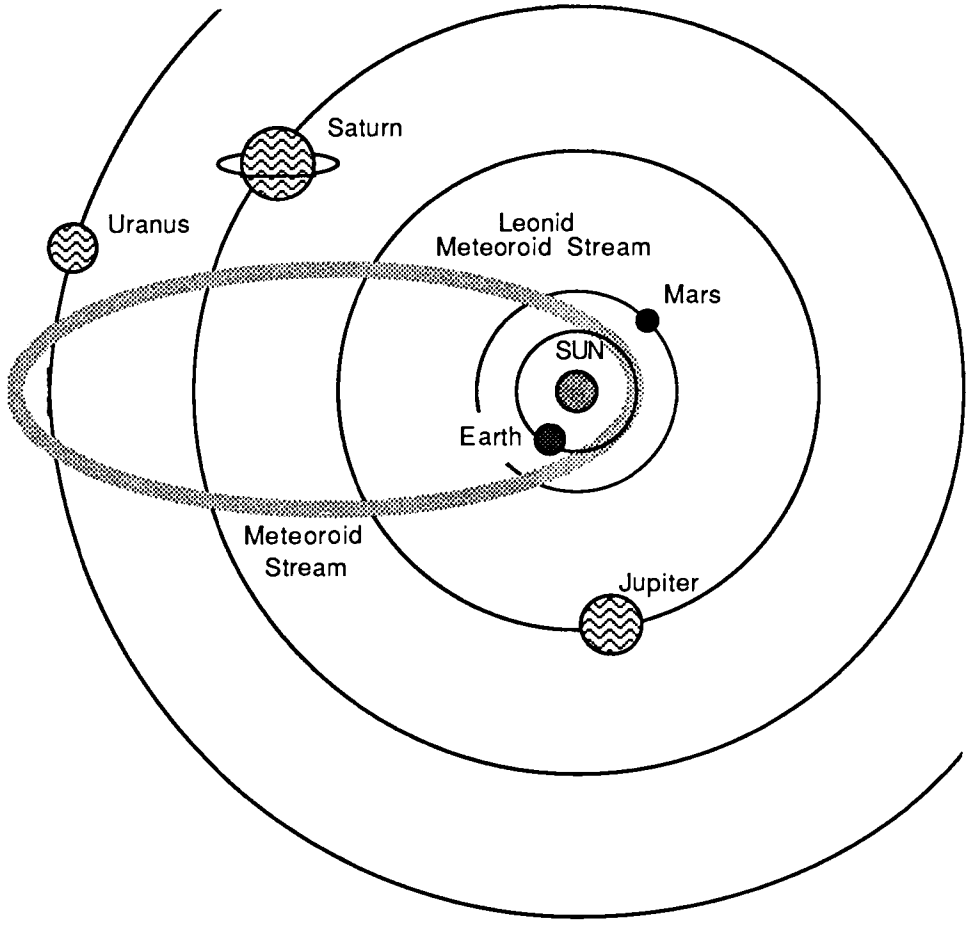
The solar wind interacts with cometary gas and dust at the shock front. Material flows away from the Sun, forming tails of ionised gases and fine dust.

HALLEY'S COMET



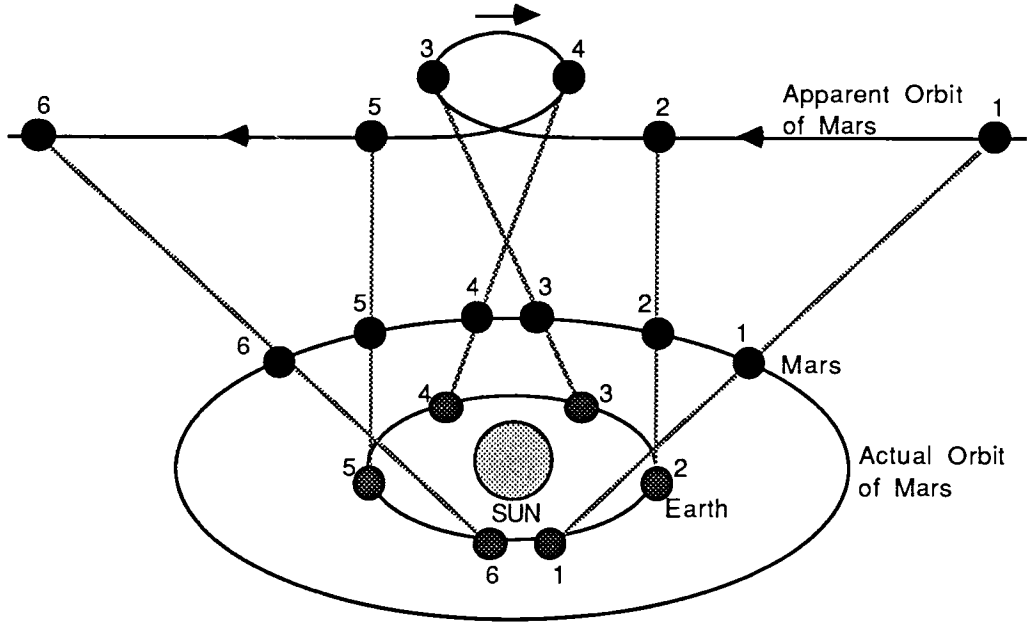
The orbital period of Halley's Comet is 76 years.

METEOROIDS



The above diagram shows the orbit of the Leonid Meteoroid Stream. The orbit extends from near Earth's orbit to as far as the orbit of Uranus. The orbital period is just over 33 years. However, the gravitational pull of the planets affects the stream causing changes in its orbital path. In 1899 and 1933, there were no major meteor showers from this stream as it missed Earth. However, there was a major encounter in 1966. The shower peaked at 60,000 meteors per hour in a 40 minutes period.

APPARENT MOTION



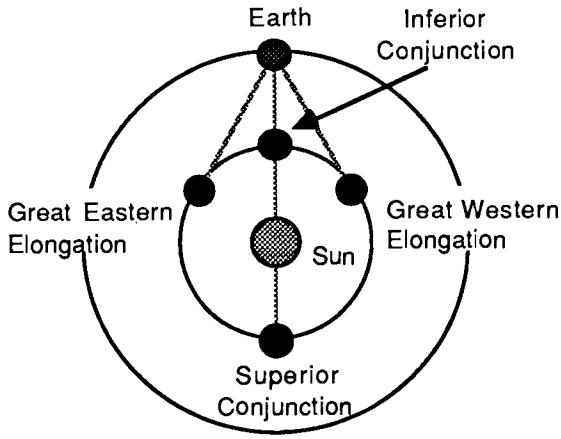
As the Earth is closer to the Sun than the superior planets, its orbital speed around the Sun is greater. As a superior planet approaches opposition, it appears from Earth to stop and then backtrack on its path for a few weeks.

The above diagram shows the apparent motion of Mars as it comes to and passes through opposition. Note that the planets orbit the Sun in a counter-clockwise direction.

At 3, the Earth begins to "overtake" Mars because of its greater speed. As seen from Earth, Mars appears to stop its forward motion and loop back on its path for a few weeks.

At 4, it reaches the end of this backward motion and appears to move forward again along its original orbital path.

OBSERVING THE PLANETS

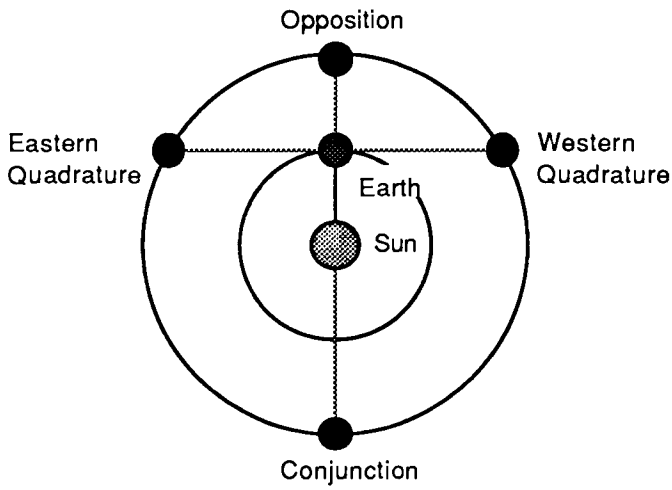


INFERIOR PLANETS

The orbits of Mercury and Venus lie inside that of the Earth. Because of this, they are called the Inferior planets.

Pretending that the Earth is stationary, this diagram shows how the inferior planets move around the Sun as seen from Earth.

On the far side of the Sun, at a point called Superior Conjunction, an inferior planet is invisible from Earth. It is usually invisible again at Inferior Conjunction as the Sun is directly behind it. At eastern elongation, the planet is visible east of the Sun in the evening. At western elongation, it is visible west of the Sun in the morning.



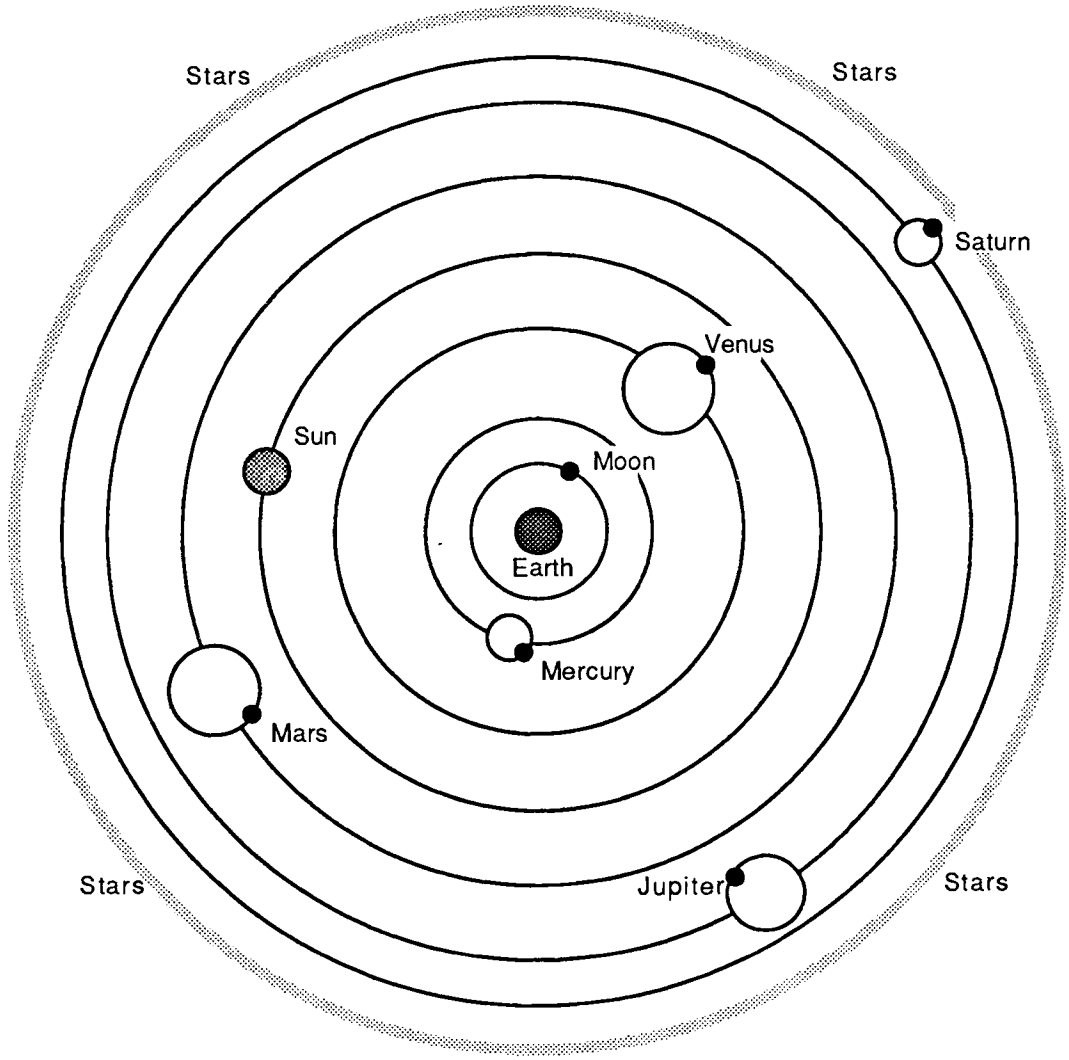
SUPERIOR PLANETS

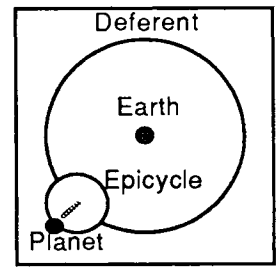
The Superior planets have orbits which lie outside that of Earth.

Pretending that the Earth is stationary, this diagram shows how the superior planets move around the Sun as seen from Earth.

At Conjunction, a superior planet is behind the Sun and therefore invisible. At opposition, it is closest to Earth and at its most visible. At quadrature, the angle of the planet-Earth-Sun is a right angle.

PTOLEMY

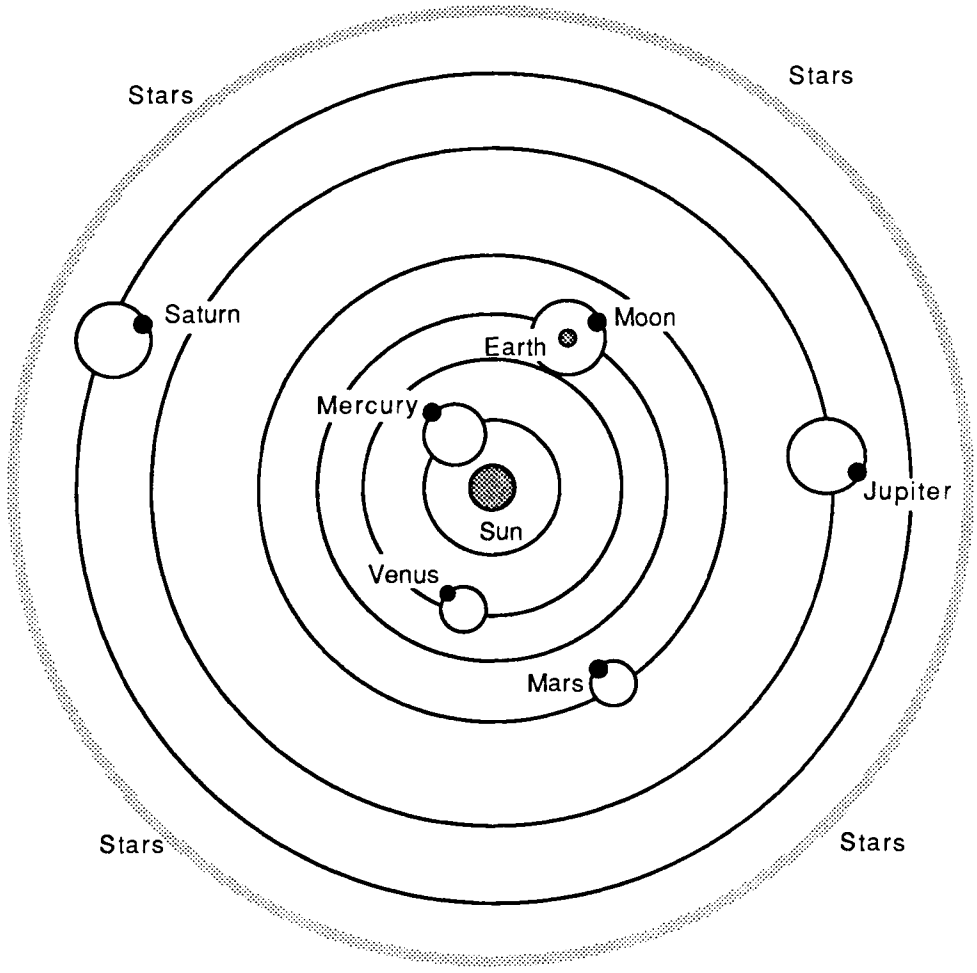




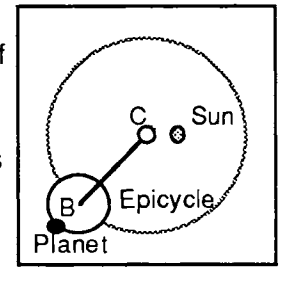
Ptolemy claimed that the Earth is the centre of the universe. In the Ptolemaic system, the Earth lies stationary while the Moon, Mercury, Venus, the Sun, Mars, Jupiter, Saturn and the stars move around it.

Each planet moves in a small circle called an epicycle. The imaginary centre of the epicycle moves around Earth in a larger circular path called the deferent.

COPERNICUS

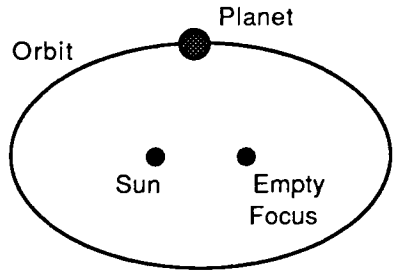


Copernicus claimed that the Sun is at the centre of the solar system. According to the Copernican Theory, Mercury, Venus, the Earth and the Moon, Mars, Jupiter and Saturn move in circular orbits around the Sun which is offset from the centre of their orbits.



Each planet moves in two uniform circular motions: one is an epicycle around an imaginary centre B, and the other a uniform motion of B around the imaginary centre of the orbit, C.

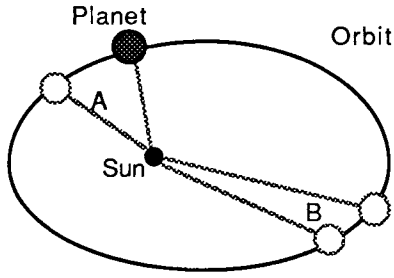
KEPLER'S LAWS



Sun at one focus, the other is empty

FIRST LAW

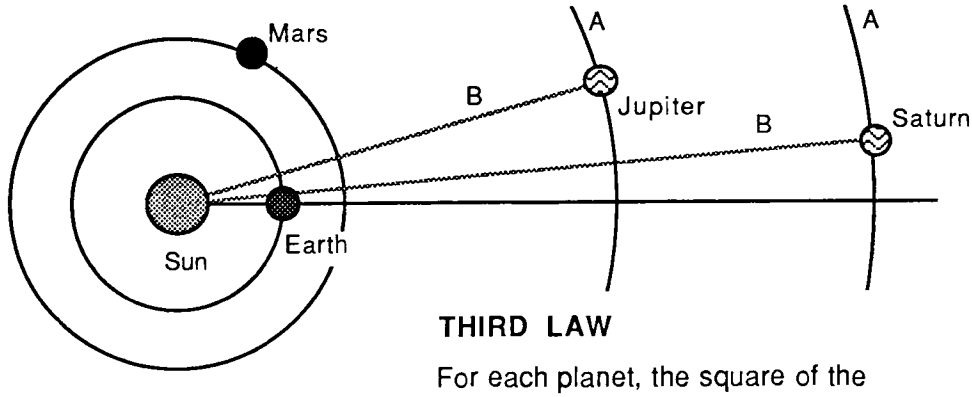
Each planet moves in an elliptical orbit with the Sun at one focus and the other focus empty.



A and B are equal areas

SECOND LAW

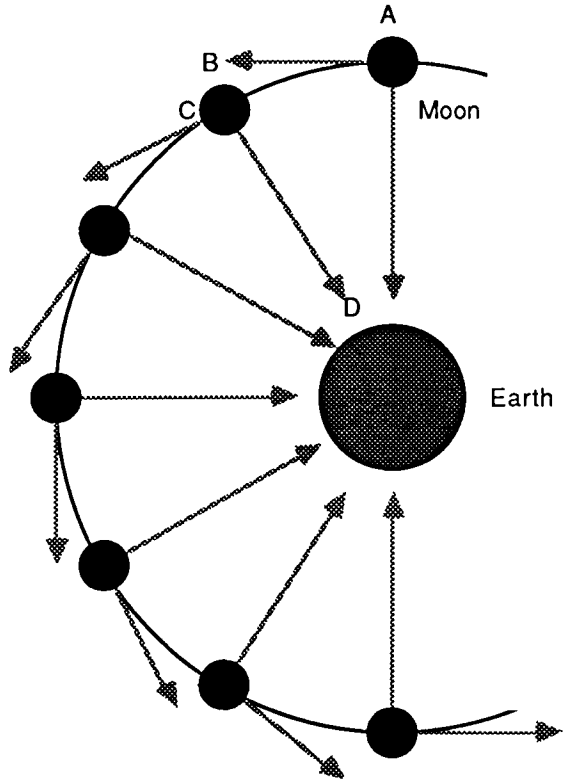
Each planet revolves around the Sun so that an imaginary line connecting the planet and the Sun sweeps out equal areas in equal times.



THIRD LAW

For each planet, the square of the revolution period (A) is directly proportional to the cube of the planet's mean distance from the Sun (B).

NEWTON



Isaac Newton claimed that every body continues in a state of rest or of uniform motion in a straight line until that state is changed by the action of a force (gravitation) on the body.

In the above diagram, the Moon would move from A to B if not influenced by Earth's gravitation. Instead it moves from A to C. There is therefore a change in velocity from B to C which has a component (C to D) towards Earth. It is Earth's gravitation which causes this and keeps the Moon in orbit.

U.S. SPACE BUDGET

YEAR	NASA	DEFENCE	OTHER	TOTAL	
1971	3,101.3	1,512.3	127.3	4,740.9	
1972	3,071.0	1,407.0	96.7	4,574.7	
1973	3,093.2	1,623.0	108.7	4,824.9	
1974	2,758.5	1,766.0	115.8	4,640.3	
1975	2,915.3	1,892.4	106.6	4,914.3	
1976	3,225.4	1,983.3	111.2	5,319.9	
1976	849.2	460.4	30.9	1,340.5	Transitional
1977	3,440.2	2,411.9	130.7	5,982.8	
1978	3,622.9	2,738.3	157.0	6,518.2	
1979	4,030.4	3,035.6	177.5	7,243.5	
1980	4,680.4	3,848.4	160.0	8,688.8	
1981	4,992.4	4,827.7	157.7	9,977.8	
1982	5,527.6	6,678.7	234.4	12,440.7	
1983	6,327.9	9,018.9	241.7	15,588.5	
1984	6,648.3	10,194.9	292.5	17,135.7	
1985	6,881.4	12,813.8	426.3	20,121.5	(estimate)
1986	7,263.9	15,846.5	418.5	23,528.9	(estimate)

Figures are expressed in Millions of Dollars
The source is the Aeronautics and Space Report of the President - 1984 Activities