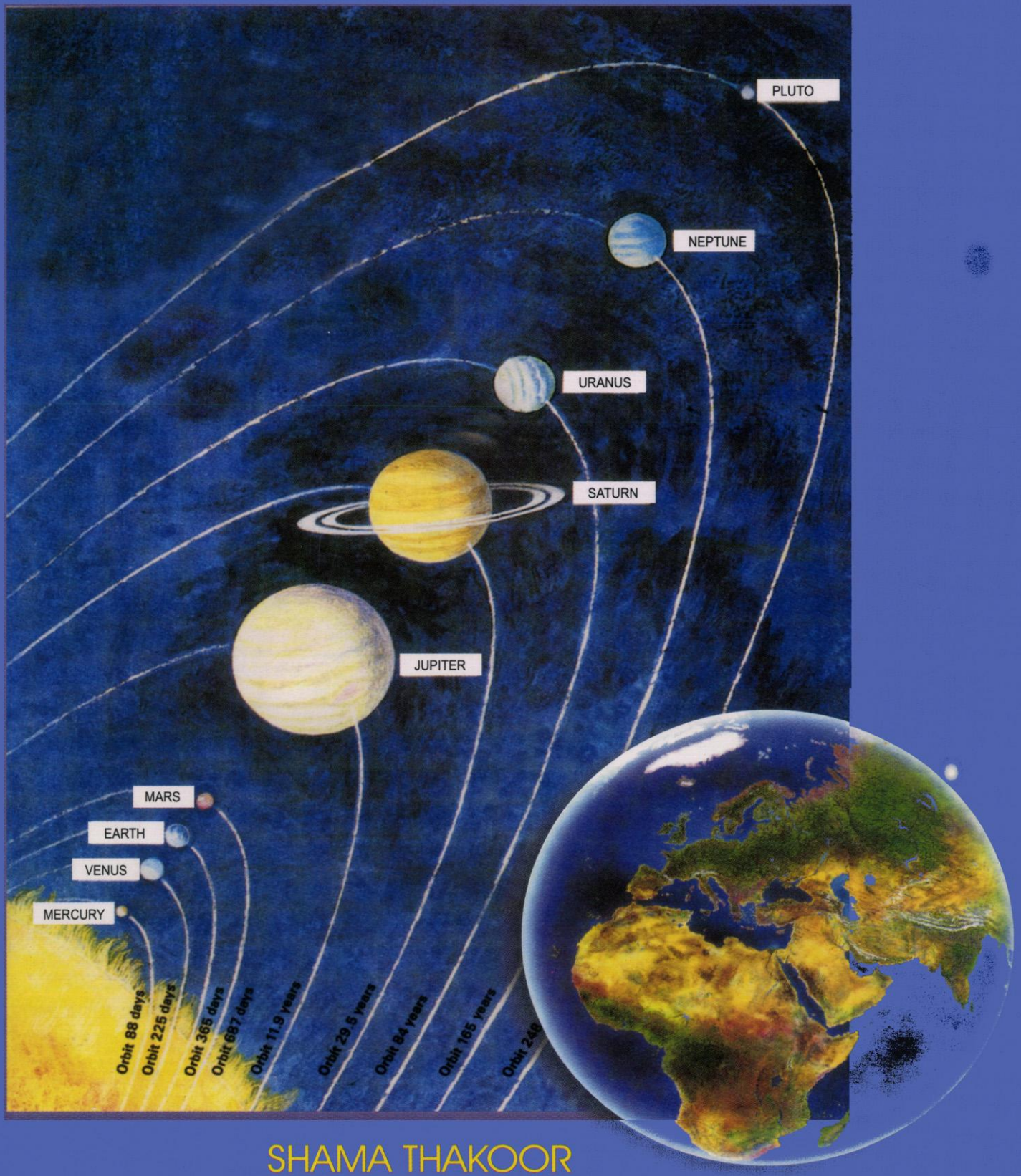
OUR SOLAR SYSTEM AND HOME PLANET...THE EARTH



SHAMA THAKOOR

Himalaya Publishing House

"OUR SOLAR SYSTEM AND HOME PLANET... THE EARTH"

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Himalaya Publishing House
MUMBAI ● DELHI ● NAGPUR ● BANGALORE ● HYDERABAD

Note: All the paras in inverted comas, indicate that the paras are taken from "The Young Oxford Book of Astronomy" London, U.K. by Simon and Jacqueline Mitton.

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DEDICATED TO MY LOVING HUSBAND

Late Shri Narottam Thakoor

who has just recently passed away

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॥श्री॥

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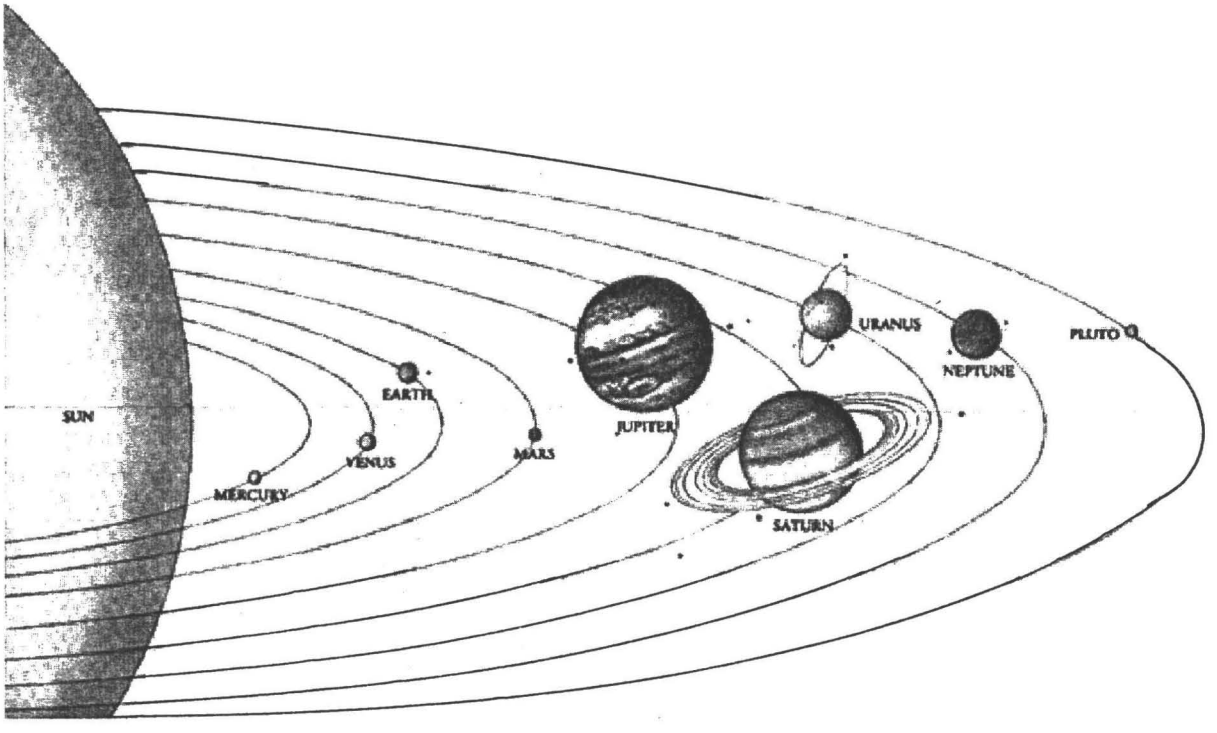
PART - I

OUR SOLAR SYSTEM



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CHAPTER 1

THE ORIGIN OF THE UNIVERSE AT A GLANCE

BIG BANG

Hello:

My dear youngsters, or better I can say teenagers. I am your Shamaaji, Shama + Aji (Shama is my name and Aji means grandma in Marathi) Grandma is always interested in telling stories to grandchildren and they also love to hear her stories. Mostly grandma always tells stories about small children, fairy tales, Kings and Queens, Prince and Princess, some animals in Jungle etc. etc.

But what we are going to discuss about now, is totally different. It's very much interesting, but one thing you have to do is that, you have to read it with full concentration and then you will find it more and more interesting. Once you start reading it and develop appetite for it, you will like to read it again and again and more and more about it. And perhaps in future you may become a Master of the subject. Who knows!

Now guess what must be our subject! Dearones, it is our own house, the Earth. The Earth where we live. You know that our Earth is not alone or singly living in the sky. There are so many things in the sky alongwith our Earth. While thinking about it, lots of problems jumble up in our mind.

Our Earth is a part of our Solar System, which itself, is a very small a minute part of the Gigantic Universe. Now, where is the Earth, where is the Solar System, are there other bodies like these, what is their relation with each other, how they have formed, how old are all these objects and so on.

Every night we see that the sky is full of so many stars and planets, boundryless, spreading far away, we do not know how far they are. All the objects in the sky are called celestial objects, that means the objects which are there in the sky, or better say in the deep space. Space is made of nothing, but it has lots of things in it, the stars, the planets, the moons and innumerable other things, alongwith living things also. The space alongwith all its contents is called the Universe. Friends, we are going to discuss about a very small part of the Universe, "Our Solar System and Our Home Planet The Earth." Hai na Majeki Baat!

But before starting our subject, we must take a glance at its origin, the Universe.

The Universe is supposed to be an outcome of Colossal explosion called **Big Bang**, somewhere between the period of 15 billion to 20 billion years ago. There are some 2/3 other theories also, but mostly and widely accepted theory about the birth of the Universe is Big Bang.

Before the Big Bang took place, there was only enormous and boundryless space consisted of only huge clouds of dust and hydrogen gasses. Initially, matter and radiation converted into each other and the Big Bang took place in such a short time that we cannot even imagine it. It is said that the matter exploded so quickly that within a hundredth of second the universe was formed in its crude form and the matter was converted into tiny particles such as Protons, Electrons and Neutrons. Then these particles joined together in permutation combination and formed various sorts of atoms, which are basis of huge variety of different materials and can link together to form molecules.

Thus, the atoms or the matter created came together in huge clumps and formed galaxies, smaller clumps within the galaxies formed stars, even smaller clumps became a group of planets and other celestial objects.

The Universe is so large and vast, that we cannot even imagine how far it is spread and what it is as a whole! Our scientist also do not know whether there is anything beyond, what they are able to see with the help of their instruments. They are able to see about 17 billion light years in space in every direction, beyond that nothing could be said.

In short, each and every thing that can be seen through our naked eyes or with the help of telescopes, however big or small the thing is, even living thing, is a part of the Universe, or we can say nothing is there which is not a part of the Universe.

The Astronomers were not sure whether there are other Solar Systems or planets as they had not found any of them, because the galaxies are so distant and are accompanied by interstellar matter like dark thick clouds, misty patches, nebulae etc.

It becomes impossible to find out but it was assumed that they do exist and in course of time astronomers will be able to find them out.

The Astronomers have found that the Universe is still enlarging though not at very fast rate, slowly and slowly all stars, galaxies and matter are moving further and further.

Every year some new stars are born and some old ones fade away. It cannot be said how long is the life of the Universe. It depends upon how much the hydrogen and the helium is there. As long as these two are there the Universe will continue.

There are some important characteristics in the Universe. The study of which is not our subject at this stage. I am simply mentioning them here. Some of them can be studied with the Solar System.

1. Asteroids
2. Meteors & Meteoroids
3. Shooting stars — Within Solar System
4. Constellations
5. Comets

6. Pulsar
7. Quassars
8. Nova — Objects from Universe
9. Supernova
10. Black holes
11. White dwarfs

NEW DISCOVERIES

We have seen that the scientists are trying to search other solar systems. However, they have not found any as yet. But scientists were sure, that they do exist. Only because of the enormous distance and obstruction of interstellar matter, they were unable to find them. And now really its wonderful. About eighty extra planetary systems have been found by astronomers by using Hubble space Telescope.

Oh! Yes, and now within a year only, they have found three of them! (2001), so thrilling it is!

1. *Appeared in the Times of India, Mumbai Edition, dated Friday 17th August, 2001.*

"Scientists Orbiting into new space, found Earth like Solar System!"

2. *Appeared in the Economic Times, Mumbai Edition on Thursday the 29th November, 2001.*

"Hubble Studies Planet, 150 light years away" "Nasa". Nasa has announced "Roughly Jupiter sized planet, which orbits around a star similar to our Sun".

3. *Appeared in The Economic Times, Mumbai Edition on Wednesday the 9th January 2002.*

"A quite big brown dwarf is found orbiting a Sun, very nearly similar to our sun, 57.7 light years away".

Note: The sentence/para in inverted comas indicate that the said sentence/para is/are taken from *The Young Oxford Book "Astronomy"* by Simon and Jacqueline Mitton, London, UK.

• INTERSTELLAR MATTER

We have seen that there are billions of stars in the sky, and we see them as if they are very close to each other. But actually they are not, our Sun is one of those billions of stars. There is immense distance between stars. We could not even imagine it. The space in between the stars is not empty. It is full of atoms of gas and particles of dust floating throughout space. This matter between the stars is known as interstellar medium, it is very thin. Astronomers call the space, dust and gas as interstellar matter. This matter creates a thin haze that dims the light from distant stars.

In some places due to the force of gravity, gas and dust have been collected together to form thicker clouds. There are different types of these clouds. The huge dark clouds because of whom the star light behind these clouds could not be seen. There are huge clouds and swirling masses of gas and dust called misty patches. Besides there are also glowing clouds of gas called Nebulae, which emit pinkish light. These Nebulae are among the most beautiful objects in the sky. All galaxies have their own Nebulae having different colours, different sizes and shapes.

It is very exciting that the astronomers have found that the new stars are being made inside these gas clouds, that is interstellar matter. A new star begins when protostellar material that means particles of gas and dust and nebulae collect into a huge ball and it squeezes tighter and tighter and gets hotter and hotter, because of the gravitational pull. Again, in due course the gravitational contractions heated the protostar (the star which is being made — a huge ball of gas and dust) so much that it becomes hot enough to start nuclear reactions, in the hot dense protostar and then it starts shining of its own accord and condenses at its center and settles down to be a star. Thus our Sun is also born in the same way, within the interstellar matter, the clouds of gas, dust and nebulae, about 5 billion years ago.

"An atomic nucleus is made up from two kinds of particles – Protons and Nutrons. They are held together by strong nuclear forces. Protons Carry a tiny amount of positive electric charge but Nutrons have no charge. Both have about the same mass. Around the nucleus, a cloud of electrons forms the outer part of the atom".

"Each electron carries the same quantity of electric charge as Proton, but it is of the opposite (negative) kind. The force of attraction between the positive charge on the nucleus and the negative charge on the electrons holds them in place in the

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atom. Electrons are much lighter than protons and neutrons. Almost all the mass in an atom is concentrated in its nucleus and most of an atom is made of empty space".

"These particles (Protons, Nutrons and Electrons) joined together in a permutation combination and formed various sorts of atoms, which are the basis of huge variety of different materials and can link together to form molecules. Thus, in time the atoms or matter created came together in huge clumps and formed galaxies, smaller clumps within the galaxies, formed stars, even smaller clumps became a group of planets and other celestial objects".

• GALAXY

Galaxy is a group of stars which also consists planets, moons and other celestial bodies. The stars, planets, moons are all round, spherical in shapes. There are billions of galaxies in the Universe, may be 100 billions, which are systematic clusters of stars. These groups appear as spiral or discs, technically known as ovoid. We cannot see all of them. What we can see in the sky is a very short, a minute portion of the Universe, the part we can see from our place on Earth, is a very very small part of our Home Galaxy.

Our Home Galaxy (The galaxy in which our Solar System exists) is called "The Milky Way." Every point of light, we can see in night sky, is a star in our Milky Way Galaxy. There are 100 billion stars in it. The diameter of our Milky Way Galaxy is 1,00,000 light years. Our Sun is about 25,000 light years away from the centre of the Milky Way Galaxy. All the stars visible in the night sky belong to our Milky Way Galaxy.

At night we can see a hazy (faint) band of light in the sky, the parts of which can be seen from every where on the Earth. This faint band of light looks some what like milk's flow and it is called "Milky Way". This faint light comes from the stars that makeup the "Milky Way Galaxy".

"The regions with few stars are clouds of smoke and dust and soot and grains of sand, are sitting out there in deep space and they block our view of the stars in the Milky way. This fog in the outer space, blocks so much light, that if we could blow it all away, one would be able to read a book at night by the bright light of the Milky Way alone!"

There are various types of galaxies, some are ovoid, some are spiral, some are elliptical, some are globular, while some are clusters of galaxies and so on. Our Milky

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Way Galaxy is a ovoid and spiral Galaxy and our Solar System is in one of its spiral arms. The Milky Way Galaxy has a family of neighbouring galaxies togetherly known as "Local Group". Our neighbouring biggest galaxy is known as "The Andromeda". There are 200 billion stars in it, and it is 2 million light years away from our Milky Way Galaxy. Our galaxy and Andromeda galaxy are the main parts of "Local Group" and there are also M31 and M33 and large and small Megellanic clouds which are the members of "Local Group".

There are billions of spiral galaxies in the Universe and they contain many young stars. There are enormous distances between galaxies and they are grouped in clusters. There may be thousands of galaxies in each cluster. Clusters of galaxies may again be grouped in super-clusters. There is always heavy bulge at the centre of the galaxies. The scientists have discovered that there is a huge amount of hot gas at the centre of our galaxy. Some experts think that this may be caused by an enormous black hole which is slowly sucking in dust, gas and light.

It is because that at the centre of the galaxies stars are so thickly grouped, that they appear as a heavy bulge. Actually stars are not close at all but because of the enormous distance from us they appear to be so close, as a heavy bulge. As we start to look away from the centre we can see little distances between them, but actually it is a vast distance. Scientists have found that Universe is still enlarging slowly and slowly though not at very fast rate. All stars, galaxies and matter are moving further and further, and distances among them is widening, and the Universe is getting enlarged.

• STARS

A star is a huge ball of hot gas having its own gravity and nuclear Energy. Every object in the universe has a gravitational force, it means every body has a power to pull other body towards itself. Stars have greatest gravitational force, then planets etc. Even a smallest asteroid has this force. This gravitational force holds the whole solar system together, as each planet moves on an elliptical orbit around the Sun.

The distances between the stars is immense and they differ in their brightness. This brightness depends upon the distance from us as well as its luminosity. This brightness is called its magnitude. When the magnitude is lower, the star is brighter and when the magnitude is higher, the star is fainter. A star of O magnitude is very bright whereas stars of magnitude 5 are just visible. The brightest stars have minus magnitude – Sirius is the brightest star in the northern sky and has a magnitude of minus 1.5.

Each twinkling point in the night sky is really a distant star. The stars are not scattered evenly through all of space. The Sun and all the stars that can be seen by eye belong to our Milky Way Galaxy. Some of the stars in the galaxy are alone like the Sun, but many are linked in double, triple and quadruple system. Stars also form larger groupings called clusters. Two quite distinct kinds of clusters are found, open clusters and globular clusters. Open clusters are loose collections of stars about 1000 in all. Globular clusters are tightly packed balls of stars, here stars at the end can only be picked out.

The stars are self illuminating. They always shine and twinkle. It is because however big or small the stars are, they have a great power generating energy, whereas the planets do not have power generating energy and do not have their own light. What light we see on the planets is the light they receive from the Sun or Stars. The light we receive from other planets is only the reflection of light, they receive from the Sun. The Stars always twinkle, because the light they send towards earth is bent by air currents moving about in our atmosphere, that means the air current scatter the star light while entering in the earth's atmosphere and hence causes fluctuations in brightness. The astronauts travelling above earth's atmosphere, could find that stars do not twinkle at all.

All the stars in the universe are in galaxies but there are no stars between the galaxies. The stars and planets are so far away, that the distances between them could not be measured in kilometers, the number will be enormous. So the scientists have found a method of measuring these huge distances, that is light year and also parsecs but parsecs is mostly used by scientists. Light travels at 300000 km. per second, so the light year is the distance, light travels in one year and this light year is 460,000,000,000 km. compared to light sound travels at very slow rate and that is about 1000 km. per hour. Lightening and thunder happen at the same time, but it is because light travels much faster than sound, we see lightening first and immediately after some time we hear the thunder sound.

There are so many stars similar to the Sun. Yet there are giant stars as big as the Solar System and dwarfs of the size of the earth. The nearest star to our earth other than the Sun, is Proxima Centauri. Actually it is a group of three stars – Alpha Centauri A Alpha Centauri B and Alpha Centauri C.

Most visible light in the universe is emitted by stars only. A star is a ball of gas that produces light and heat. Now here, the question is, how much light a star is producing exactly? An answer involves, measuring the stars brightness as seen from the earth and the star's distance from the earth. Astronomers measure the apparent brightness of stars through the magnitude scale. This scale originated when Hipparchas made the first star catalogue, in the second century B.C. He classified the stars

according to their brightness, labelling the brightest stars, first magnitude, the next brightest second magnitude, and so on, to the fifth magnitude. Since his catalogue was so much useful, that astronomers kept the magnitude scale rather than adopting a more logical one thus magnitude scale goes backwards, big (positive) magnitudes mean faint stars and small (negative) magnitude's mean bright stars.

Star's magnitude is of two types — apparent magnitude and absolute magnitude. The intrinsic brightness of a star or how much energy it puts out into space, is the star's luminosity. To measure this you measure the star's magnitude, as seen in the sky, or its apparent magnitude and its distance from you. If you know that distance, you can then calculate, how bright it could be, if it were at some standard distance, such as ten parsecs, from the earth. The star's magnitude at a distance of ten parsecs from the earth, is its absolute magnitude. Astronomers sometimes put some stars at an imaginary distance, all at a same distance, say ten parsecs from earth and calculate the brightness of those stars on that distance and they can get real difference of brightness of those stars and from this they can find out luminosity of those stars or how much energy they put out into space. This is called absolute magnitude. Thus absolute magnitude is related to stars luminosity.

Once you know the luminosity of a star, you have to find out whether it is luminous because it is large and cool or small and hot. You want to know its surface temperature, one way to determine it is to look at star's colour, hot stars are blue and cool stars are red. Another way is to look at its spectrum.

The stars are too hot and huge spheres of a glowing gas, generating nuclear energy in their cores. When the hydrogen inside them turns into helium, it releases a great energy in the form of light, heat and some other invisible rays. Thus the Sun is continuously generating energy in its central core to replenish its heat. This generated energy balances the energy lost into space, so that the Sun can continue to hold up. Energy generation maintains the core temperature and the core pressure as that the Sun can continue to hold itself up, to shine and to keep us warm. Sun's energy source is nuclear fusion.

The stars life depends upon their power of generating energy. Stars live for billions of years. Some times biggest stars have short life and smallest have much more. Our Sun is a normal star having total life of ten billion years. At present it is five billion years old. That means it is middle aged now. In the end stars either explode giving birth to some new star or just fade away. This process is a very long one but it always carries on. Thus every year some new stars are born and some old ones die, that mean they become white dwarf or neutron star or black holes depending upon their initial mass. Thus new stars and new solar systems are still being formed.

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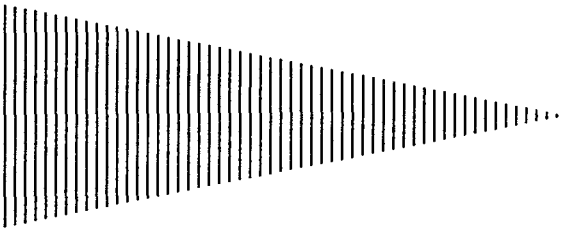

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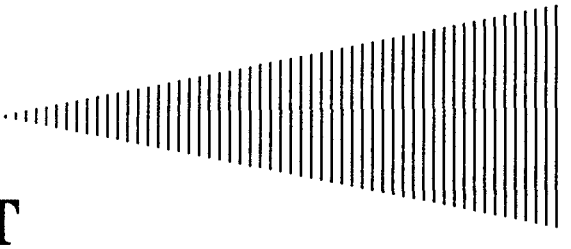


OUR SOLAR SYSTEM IN SHORT

Solar System is a group of planets and moons which circles round, or orbits a star. Every star is actually a Sun, which may have its Solar System. We have seen that there are billions of galaxies in the universe and billions of stars in galaxies. And so our Solar System is just a very minute part of the Universe. Even it is a very tiny part of our own galaxy, the Milky Way.

Our Solar System began to form at about 4.6 billion years ago, and it consists of nine known planets including the Earth, on which we live and a star called the Sun, one of the billions of stars in the Milky Way which itself was born at about 5 billion years ago. Our Solar System also consists of an Asteroid belt, Meteorites, comets and planatory moons.

All the planets travel around the Sun. Some planets have moons rotating around them. The paths of the planets and moons are called their orbits, while the path of the Sun in the sky is called ecliptic. All the planets revolve around the Sun in their own orbits, in the same way all the moons move around their planets in their orbits. Thus the planets orbit around the Sun alongwith their moons. The Sun also rotates on its axis and the whole Solar System is moving alongwith the Milky Way Galaxy. They never leave their orbits, all of them are controlled by their gravitational force.

Pole Star — The Earth is orbiting the Sun. So during the year, we get to see the stars all around the Sun. The Pole Star is directly over our Solar System, hence people living in the Northern hemisphere can see it all year round. In the same way, people living in the Southern hemisphere can see Southern Cross star all year round.

The planets are those celestial objects, that have no self generating power of light like Stars. Planets and Moons receive light rays from the Sun and then those rays are reflected. Hence the rays are very mild in comparison with Sun's rays and light. Planets are either rocky like Earth or giant gas balls of cool gas like Jupiter.

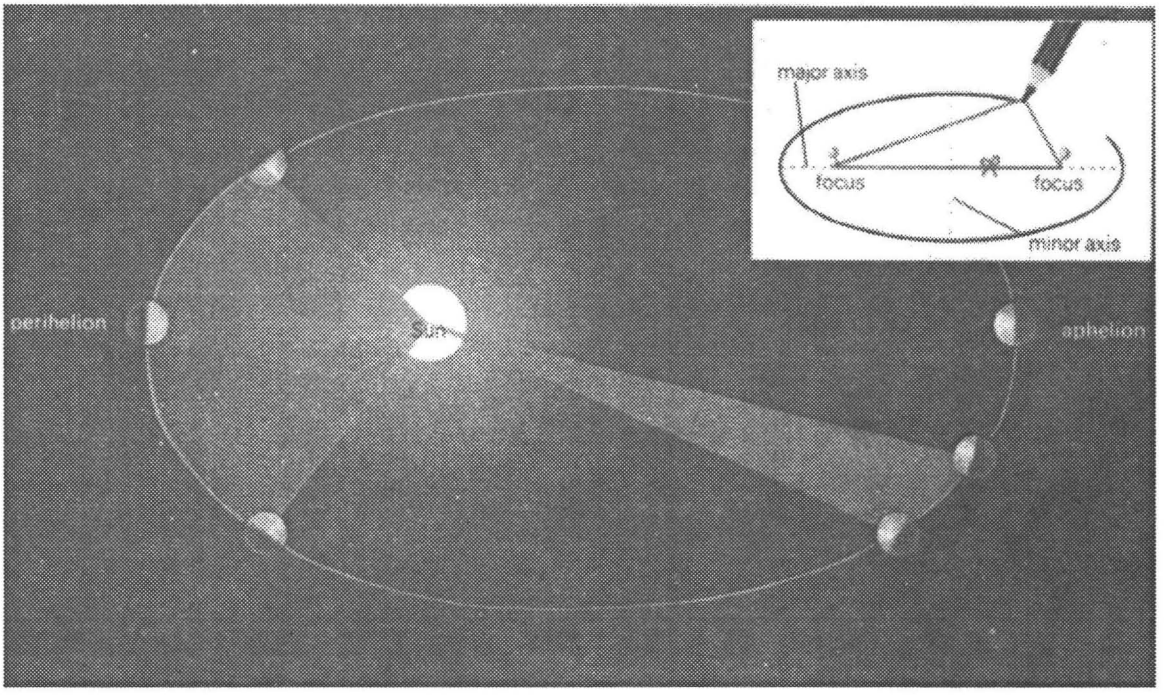
"There are nine planets orbiting around the Sun. Of the nine planets majority that means Earth, Mars, Jupiter, Saturn and Neptune rotate in a way we consider "normal". Mercury and Venus are very slow, Venus Uranus and Pluto are "retrograde", spinning backward — Opposite to their orbital motion. Uranus and Pluto are highly inclined. Mars' inclination varies chaotically over long (billion-years) time, so it is not always normal. How a planet rotates is related to how it was formed, from the accretion of planet-simals. If more impacts occurs on one side, than the other, then it will tend to rotate accordingly. But the impacts are largely random. The tidal effects can also change the rotation." *David Pamler.*

These nine planets are orbiting the Sun. The Sun is in the centre then Mercury, Venus and then our Earth, it has its own Moon. Then are the Mars and giant Jupiter, and in between the orbits of these two there is an Asteroid Belt, these asteroids are very small, and are more than 3000. Then Saturn, also a big giant having its peculiar rings, then Uranas, Neptune and Pluto. And there are so many moons of these planets orbiting their own planets. In between Neptune and Pluto's orbit there is Kuiper Belt, where there are some comets, but really speaking comets home is very far away from our Solar System, beyond Pluto's orbit and is named. "Oort cloud of Comets", which is very cool, beyond the reach of the Solar Heat, it is the icy region.

The planets near the Sun are rocky while those away from the Sun are mostly gas. Why? It is because at first rocky planets had hydrogen and helium atmosphere, but since they are closer to the Sun. The Sun's powerful solar wind blew away the gases. The current atmospheres come from the gases in the planet cores.

Each planet travels round an ellipse (Oval shape), not a circle, that means the orbital circles are slightly streached. The Sun is not at the centre of this ellipse but off to one side, at a place called the focus. The more squashed the ellipse the further off-centre the focus. This means that the distance between a planet and the Sun varies as the planet travels round its orbit. A planet moves fastest when it is closest to the Sun and it moves slowest when it is farthest away. The time it takes to orbit the Sun depends on its distance from the Sun. Perihelion and Aphelion are the two imaginary points on the orbits of planet. Perihelion is the point of closest approach to the Sun and Aphelion is the most distant part of the orbit from the Sun. Similarly, while orbiting the Earth, the Moon also moves fastest when it is closest to the Earth

and the point is called PERIGEE and it moves slowest, when it is farthest from the earth, and the point is called APOGEE.



There are several fundamental regularities, in the structure of The Solar System. The terrestrial planets have solid silicate rock crush with interiors that are molten, while the gas giants are balls of hydrogen and helium and have a closer resemblance to the composition of the Sun than the terrestrial planets. The composition of the moons of the outer planets is similar to that of the terrestrial planets. All of them are composed of water, ice and silicate rock. Whereas the gas giants are composed mainly by hydrogen and helium, so they are known as closely related to the Sun, and their moon could be looked upon as a Solar System in the Solar System.

"Our Solar System extends outwards from the Sun to the point beyond which the Sun's gravity has no effect. The Orbital diameter of planet Pluto could be supposed as the diameter of Solar System, as Pluto is the outermost planet of the Solar System. But it is because of Pluto's eccentric orbital behaviour, sometimes it comes closer to the Sun than the Neptune's more circular and regular orbit. Hence Pluto's orbital diameter could not be used as the Solar System's diameter. The Astronomers have come to the conclusion, with the help of the mathematical calculations that our Solar System's diameter could be 2.5 light years. The Astronomers

Note: The sentence/para in inverted comas indicate that the said sentence/para is/are taken from *The Young Oxford Book "Astronomy"* by Simon and Jacqueline Mitton, London, UK.

measure intra-solar system's distances in Astronomical units (which is called AU in short) which is the distance in between the Earth and the Sun, that is 93 million miles or 150 million km., Jupiter is 5.2 AU, from the Sun, Saturn 9.54 AU, and Pluto nearly 40 AU."

Our Sun is in the centre and main figure of Solar System. Sun is very hot beyond our imagination. Without its light and heat nothing could have survived on the Earth. All the living beings should be grateful to the Sun so much that it is only because of the Sun, living beings are having their lives. Compared with the stars, Sun is supposed to be a normal star, but as compared with planets, Sun is very very big. The 99% of the total matter in Solar System is contained in the Sun only. And only 1% is contained in all other planets, their moons, asteroids, meteorites comets and so on.

"The Astronomer Johannse Kepler found out how the planets move, but it was Sir Isaac Newton, the seventeenth-century English mathematician, who realized that the gravitational force holds the planets in their orbits. The Earth's gravity makes objects that are dropped fail to the ground. If the Sun's gravity did not constantly keep tugging at the planets, they would fly off into the depths of space, because the gravity of planets is much less as compared to the Sun's gravity". The Sun is just like a king who controls and balances and governs the whole of the Solar System.

KEY DISTANCES:

1. Earth to Moon	380,000 km.
2. Earth to Sun	150 million km. or 93 million miles.
3. Sun to nearest star	4.2 light years. – Proxima Centauri
4. Sun to center of our galaxy	25,000 light years.
5. Milky Way Galaxy to Andromeda Galaxy	2 million light years.
6. The diameter of our Milky Way Galaxy	1,00,000 light years.
7. The diameter of our Solar System	2.5 light years.

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NEW DISCOVERY

News appeared in Tuesday October 8, 2002 in The Times of India Mumbai Edition

Friends, there is a great news in today's Times of India. Do you know what it is? One new object or we can say a new member is found in our Solar System, in the swarm of objects, made of ice and rock in Kuiper Belt, beyond Neptune, which means we are ten members orbiting around the Sun and not nine, as we were knowing it up to this time. Is it not a great finding?

Actually, this object is discovered beyond one billion miles of Pluto. It is about half the size of Pluto. Astronomers have named the new find as "Quaoar" (is pronounced as Kwah-O-Wahr).

News appeared in Marathi Newspaper "Loksatta" Mumbai edition, Friday 26th October, 2001.

"Odisee" space-craft enters the orbit of Mars"

The news has been given in brief and translated in English.

Nasa's Odisee space-craft has successfully entered the orbit of Mars. Before this Nasa had tried two times to do the same, but the missions were unsuccessful.

This time, before entering the space-craft in the orbit of the Mars, the scientists and astronomers of Nasa were highly curious about its entry in the orbit of Mars. And when it entered the same, all of them were very much excited, they shook hands with each other, with great joy and pleasure. It was a success after their many years efforts.

News appeared in The Times of India Mumbai Edition on Tuesday January 15, 2002.

"X-rays define clear images of the Milky Way!" news.

News appeared in The Times of India Mumbai Edition on Friday, January 25, 2002.

"Insat – 3C Launched, will boost telecom services".

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CHAPTER 3

LITTLE HISTORY

From the ancient period at about 500 B.C. People were very much interested in the starry sky, the Sun, the Moon, the planets and the innumerable stars. Some times the ancient scientists and astronomers interpreted some of them as the images of Gods. During the period, Greek and Roman astronomers were trying to study the wonders and mysteries of the Universe. But at that time, they had no necessary instruments or accessories, everything they were observing, were observing with their naked eyes only. And in some points, they had wrong predictions also. (1) For a long time, they were believing that the Earth is flat. (2) And that the Earth is at the centre and all others the Sun, the Moon, the Planets are moving around the Earth.

Upto the medieval age, people believed that the Earth is flat like a disc and that no one could live on the underside of the Earth, as they could fly off the Earth. But afterwards, it was proved to be untrue. And it was confirmed that the Earth is not flat like a disc, but is a sphere, shaped like a ball. No part of the Earth can be underside, as it is a sphere, and all objects in the Universe are spheres.

The Earth is always pulling things on its surface, each body in the Universe has a force, that attracts the other bodies. This force, now we know as Gravity, which the scientists were trying to discover for more than 300 years.

From about 500 B.C. Greek, and Roman Philosophers and the scientists were trying to search the wonders and mysteries of the starry sky. Now, it is the 2001 AD, and during such a long period, so many scientists and astronomers from throughout the world have made such a great progress on this subject, that a common man has also come to know many wonders and mysteries of the Universe. During the medieval age, the scientists and astronomers discovered small telescopes and some instruments

to guide them, and their position was better than before. And now, the scientists and astronomers have first of all made them fully equipped with the necessary instruments like big telescopes, binoculars and so on, among them, Hubble Space Telescope is the most important and a very good guide for them.

Upto the beginning of the 20th Century, it was supposed that the Solar System is the centre of our galaxy, "The milky way". But, after continuous study and very careful observations from these equipments, they found that the Solar System is not at the centre of the Milky way, but it is at one side and far away from the centre of the Milky Way.

And presently, there are so many great observatories and Institutions, in nearly all advanced countries and they are doing the search of the Universe as a team work. All the scientists, astronomers, mathematicians, astronauts, engineers and many others work there. All of them work wholeheartedly for the search of the Universe. Recently, during the year 2001, they have found some five/six main astronomical probes, such as *"an Earth like solar system"*, so thrilling it is!

During this space age, so many unmanned space-crafts and some space crafts alongwith the astronauts had been in the space, many of them were successful in orbiting some of the planets viz. Venus, Mars, Jupiter, Saturn, Uranus, Neptune and also collecting some vital data. Soviet Cosmonaut YURI GARGARIN, was the first man in space when, he made a full orbit of the Earth in VOSTOK-1 on the 12th April, 1961. Our astronauts had been on our Moon, they have stepped on the Moon. Neil Armstrong and Edwin Aldrin Jr. were the first to step on the Moon in July 1969. Miraculously, our astronomers and scientists have gained and are yet getting tremendous success in search of the Universe.

We know that the Universe is so vast, beyond our imagination, even then, we are feeling close to the Universe, as now, we know many things about the Universe. But this has not happened easily. All the scientists, astronomers, are working for such a long period with full dedication, full enthusiasm throughout their lives, many of them had no life otherwise. Thus, the subject of "Astronomy" which a common man can study now, is the "outcome" and "fruits" of all those continuous efforts, and longings to solve the astronomical probes.

Following is a mention of some important scientists and astronomers during this long period:

1. **Aristotle:** (384-322 BC). He worked in Athens, and was quite confident about the idea that the Earth is at the centre of the solar system and all other viz. the Sun, the Moon and Planets orbit around the Earth. His theory was accepted and believed for a period of 19 centuries.

2. **Aristarchos of Samos:** (310-230 BC). He had the idea that it is not the Earth, but it is the Sun at the centre of the planetary system. And he put forward his idea, but because there was not much observational evidence to support his idea and at that time, he could not succeed in persuading others that his theory was correct one.
3. **Ptolemy:** He was a famous early astronomer, who worked in Egypt. He had the same idea of Earth being the centre of the Solar System, and all others including the Sun were moving around the Earth.
4. **Nicolus Kopernicas:** (1475 to 1543 AD) – 16th Century. He was the first to say that it is the Sun and not the Earth at the center of the solar system. The Moon orbits the Earth and the whole of the Solar System orbits the Sun. But he had problems predicting exactly where the planets would be? Because, he kept the Greek idea of Circular orbits.
5. **Galileo Galilei:** (1564-1642 AD) He was an Italian astronomer and was the and first to use telescope to look at to observe the night sky. And was the first to find that it is the Sun and not the Earth at the centre of the solar system. People were strongly against this idea and he was very much condemned by Church, of course, he was right. He always believed in experiments. He discovered the four large moons of Jupiter, which are known as Galilean moons. He also discovered that the faint light of the Milky Way which we know as the hazy band comes from the countless millions of Stars.
6. **Johannes Kepler:** (1571-1630 AD) Johannes Kepler was able to improve the Copernicus's theory. First, he found that all objects in the sky are moving and not steady. Then, he also found three rules to explain the planetary motion. The distance between a planet and the Sun varies as the Planet travels round its orbit. Kepler thought that some force from the Sun must be driving the planets round, and that force must be getting weaker further from the Sun. However, he could not exactly say what force held the planets in their orbits.

   Galileo and Kepler both put forward the same idea that it is the Sun at the centre of the solar system and not the Earth. At the beginning, people were strongly against this idea and we have seen that Galileo was even condemned by the Church. Afterwards, Kepler proved the idea with the help of model made by Copernicus and improved by himself and then people were convinced and began to believe and trust the idea, "The Sun is at the centre of the solar system and all other objects orbit the Sun".

7. **Sir Issac Newton:** (1642-1727 AD) In 1665, Sir Issac Newton discovered the force of Gravity. Each object has this force. It pulls the other object towards itself. Gravity is a pulling force that keeps stars, planets and all other objects in their orbits. It is because of this gravitational force that all objects in the sky are controlled and governed, otherwise they would have fly off from their places and there would have been a chaos! Newton's gravitational theory was the first scientific law that could be used to explain observations on the Earth and in the heavens.
8. **Edmond Halley:** In the 1600s, he realized that one particular comet orbited the Sun every 76 years. Now it will next be seen in 2062 A.D. and the comet is named after Halley. Comets are periodical.
9. **Elinstein:** In 1917, he put forward the theory of steady Universe, which was proved to be untrue by Friedmann and Hubble. Afterwards he himself said that he was wrong. He is famous for his General Theory of Relativity.
10. **Edwin Hubble:** He made a space telescope, which is very important and fully equipped with the necessary things for the discoveries in space, that is astronomical probes and the telescope was named after Hubble by NASA to perfectuate his memory. In 1929 A.D. he discovered that the universe is expanding. This led to the Theory of Big Bang.

Our India has also a tradition of great scientists and mathematicians from ancient period. Banabhatta and Bhaskaracherya are quite well known among them. And recently, there are some others, who have been honoured by presenting the prestigious prize like Noble prize. We should be proud of our world renowned scientists like Dr. Jayant Narlikar, Dr. Udgaonkar, Dr. Vasant Gowarikar, and many others. Rakesh Sharma was the first Indian Astronaut to step in space craft and live in space alongwith his colleagues.

There are various types of space vehicles. From the beginning of space age, they have made an amazing development in the makings of space vehicles, with the help of which they have made such a great progress in exploring the Space and Planets and to some extent the Universe.

Satellites are space vehicles which orbit our planet Earth and relay us so many important messages. They can relay television, radio and telephone signals around Earth. Some give us weather forecasts and some look for evidences for hidden resources such as oil beneath the Earth Surface.

Space-crafts are actually space vehicles, which move in space and sometimes orbit their destinations, such as some Planets, to explore them and to collect some

messages and data from the space as well as the Planet. Space-Craft has to travel at very high speed at 40,000 km/ph. to escape Earth's atmosphere.

Our Earth's gravity is so strong that rockets are needed to push all types of space vehicles out of Earth's atmosphere and to enter into the space. Rockets are required only for the first few seconds of a space-craft's journey, they boost the crafts extra push for the lift-off, and then they fall back down to the Earth.

A space station is a large space-craft which stays in orbit around Earth. Scientists can live and work there for a long time. There are some space stations launched by some advanced countries like USA and former USSR. The Scientists and Astronomers work there in exploring the Universe. Some space crafts visit the space station to collect the messages and information and then proceed to their destinations.

"Mir Space Station" was launched by USSR in 1986. It was USSR's very prestigious project. It was a greatest space station in the world and was built in 12 parts. It remained in space for 15 years. But recently there was some break down and therefore, it was not working properly. It was due for repairs at a very high cost. Russia therefore, decided to end it up. On the 23rd March 2001, Russian Scientist and Astronomers made it to fall in the Pacific Ocean in between Chiley and New-Zealand very carefully and without hurting anybody.

SPECIAL NEWS

The news appeared in Marathi paper "Loksatta" on the 9th March, 2001 and has been given in brief and translated in English.

America's Planetary Society had organized a competition among school students from all over the world. The committee of 'NASA' selected eight boys among them, for further studies on Mars. It can be said with pride that among these selected eight boys, three boys are from our India only. Bhooshan Mahadik studying in 9th standard, hails from our Mumbai only. The other two are, one from Udaypur Shalin Harayitka and the other from Chennai Avinash Chandrashekhar.

From the very childhood, Bhooshan had the dreams of going to NASA and work for space Research. And now even before appearing S.S.C. boards exam, he got the chance to go to NASA and that too to study and explore the planet Mars.

Congratulations all of you dear boys! It is such a great achievement at this young age on your part. Wish you a great success and good luck!

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CHAPTER 4

THE SUN

The Sun is an ordinary star member of starry skies. The entire globe of the Sun is a glowing mass of gas. It is just a single star out of the 100 billion stars of Milky Way Galaxy. It is an average sized yellow dwarf variety.

The Sun is in the centre and main figure of the Solar System. It is because of its enormous distance from us, the Sun looks quite small but actually it is much more massive and one million times bigger than our Earth. The distance between the Sun and the Earth is 93 million miles or 150 million km. or 8.3 light minutes, Light and heat take 8 minutes and 2 seconds to travel this distance (Sun to Earth). The astronomers measure Sun-Earth distance as Astronomical unit called AU in short. The Sun's gravity pulls much harder than the Earth's gravity. Though all the members of the Solar System have their own gravity, the Solar System is mostly balanced and governed by the Sun's gravity and, is thought to be the king of the Solar System.

Our Sun is about 5 billion years old. The surface temperature of the Sun is very low as compared to it's core (Centre). The surface temperature is about 5500°C, whereas at it's core it is about 14 million °C. The Sun also rotates on it's axis, but it is not a solid body like our Earth, it is a gaseous body, and does not rotate like our Earth. It's different parts rotate at different speed. At equatorial region it turns fastest taking about 25 days or so for one rotation, then the rotation is slower down and in the polar region, it takes about 35 days for one rotation. This happens only because the Sun is a ball of Gas. As it is a gaseous sphere it has no solid surface, it has an opaque surface.

The planets shine with a steady light and they shine only by the light they receive and reflect from the Sun. Whereas, the Sun generates heat and light of its

own, which is much more powerful and produces enormous nuclear energy. The twinkling stars are other suns in the space. Actually they are also huge ball of gas, but because they are so distant that they always look like just a point of light. While entering the Earth's atmosphere, the air currents moving about in our atmosphere obstruct them, they scatter the light and causes fluctuations in brightness. Light from point source shimmers as it passes through the Earth's atmosphere, and we feel as if they are twinkling.

• PHOTOSPHERE

The yellow light of the Sun, as we see it, comes from a layer in its atmosphere, about 500 km. thick. The Sun is a gaseous sphere and has no solid surface and no molecular solid could exists at such incredible temperature. It merely has an opague surface as a sea of gaseous **fire storm** which is known as **photosphere**.

All of the energy and light we receive on the Earth, comes from photosphere region, but it is originally made deep inside the Sun, that means in core of the Sun. In 1930 only that physicists discovered that the Sun and stars have thermonuclear reactions and are like huge nuclear power stations. Our Sun or Stars are giant balls of super hot gas that produce heat, light and many other kinds of energies. And the wonderful thing is that, this energy takes millions of years to be produced and to come from its core to the surface of the Sun, but from the surface it takes only 8 (Eight) minutes and few seconds, to reach the Earth, the distance of 150 million km! It's really mysterious. is it not ? The nuclear radiations in the core of the Sun burn five (5) million tons of hydrogen matter into helium, each second, even then we have seen that the Sun has another 5 (five) billion years of life. Just imagine how much matter the Sun has!

The energy generated from the Sun is called **Solar radiation**, which after reaching the surface of the Sun radiates out into space. Much of this energy becomes visible light, and there are some other energies also viz. infrared light, x-rays, gama rays, harmful ultra violet rays, radio waves, micro waves and in the form of solar wind and so on. Thus Sun emits both heat and light, which are the most important aspects for life, but as well it also emits the harmful rays like ultraviolet rays and damage the cell in plants and animals. But, thank God! The Earth's atmosphere soaks up almost all these harmful radiations and the life on the Earth is protected. Direct light can do permanent damage to human eyes, so one should always take necessary cares while looking at the Sun.

The Sun is an unique and vital to all living beings. Only because of the Sun's existence life is possible on Earth. The Sun provides light, heat and necessary gasses

which are the basis of the life, without which life could not have been possible. Some scientists say that any changes in the Sun's output of energy may alter the climate on the Earth.

"The Sun's surface is bubbly, the froth is called the Solar granules, it can be seen only with the Solar telescope. It is similar to that seen when milk or gravy is boiling. The convection in the Sun's atmosphere is carrying heat energy from the lower levels to the photosphere causing the frothy texture". The fire storms that comprise the photosphere are roughly 600 miles in diameter and appear as granules as compared with the vastness of the Sun. "The photosphere's upper layer moves in and out once every five minutes or so. So the Sun is vibrating like a ringing bell, by studying these vibrations astronomers hope to discover, what the inside of the Sun is like". Along with the typical granules there are super granules also.

Solar Flare

Solar flares are huge clouds of glowing gasses which loop above the Sun's surface. Actually they are violent surface eruptions that explode from the chromosphere, a region above the photosphere. Can you imagine how much energy they carry with them? Energy of 10 (ten) million hydrogen bombs is carried away as a stream of Solar Electromagnetic radiation and particle. which can disrupt radio signals on Earth. Again photosphere activities are varied, sometimes it is very "active" while sometimes it is "quiet". During the Sun's active periods Solar flares could be from several to single Earth day. And when the Sun is quiet, Solar flare could be just one or so, per week. The energy for individual flares may take several hours or even days to build up. But actual flares happen in the matter of minutes, when the energy is released. The changed particles release in the flares are attracted by the Earth's magnetic field and spiral in at the north and the south poles causing Aurora Borealis in the Earth's atmosphere.

The Aurora

The weather in the Sun's atmosphere, is very different from that on Earth. Magnetic storms and explosions, that means, flares, blow up without warning on the Solar Surface. In some ways they resemble thunderstorms on Earth, because the energy stored in the solar energy Magnetic field is released. The Earth is affected by the Solar storms, the Sun's flares blast charged particles into space, which have wonderful effects on Earth's atmosphere.

"If clouds of electric particles from Solar flares reach the Earth, they create marvellous curtains of shimmering light in the sky, seen in polar regions, known as

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the aurora. The aurora is unpredictable and therefore very difficult to observe. It can take various beautiful and marvellous forms of arcs-rays, curtains of light in the sky, and there are never two similar displays. It is essential, a moonless night to be there, to see this Borealis Aurora and it can be seen very easily in far Northern or far Southern latitudes, that means the polar regions". The dancing light of the aurora is amazing and such a beautiful sight that *people of polar regions are always* longing and waiting to see them.

But the giant solar explosions are very dangerous also. In a few seconds they blast out more energy than all the electrical power stations in the world, and can damage electricity supplies. Electrical currents from the Sun force the power stations to shut down and destroy equipments, if such giant Solar explosions are there. The high-energy particles from the flares can damage human body.

The Sunspots

The sunspots are the dark regions on the surface photosphere, which are cooler than the other areas of the photosphere. They vary from time to time. Like Solar flares sunspots occur with less frequency during the Sun's quiet period. At the beginning of 11 years cycle period, the sunspots starts occurring, and they grow larger and larger, and also increase in numbers. At about 11 years cycle period they come upto a maximum. During Sun's quiet periods, there may be no observable sunspots while during active periods there may be more than hundred on the photosphere at one time. When the Sunspots are at their highest level, they can affect the weather on Earth. After this they start lowering down, and again there is a quiet period of the Sun. They usually occur in groups and large groups may have a life span of several weeks, they vary in size and shape. As compared to photosphere, sunspots are cooler and less bright. The sunspots specially the giant ones are the regions where the strong magnetism inside the Sun wriggles through the surface layers. Large sunspots are bigger than the Earth, and may last for a couple of months.

The Solar Cycle

The Solar Cycle is the periodic change in the number of sunspots. The number of sunspots that can be seen on the Sun varies from time to time. It is found that the Solar Cycle is an 11 year cycle. On average, sunspots come upto a maximum about 11 years. The frequency of sunspot activity occurs in an 11 years cycle, that seems to have an effect on our Earth's weather. After every solar cycle, there is a Sun's "quiet" period. During this period there are no sunspots. At the beginning of

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11 years cycle period, the sunspots start occurring and at about 11 years cycle, they come upto a maximum, that means they are at their highest level and after some time they start lowering down, thus there is a "quiet" period of the Sun again and the Solar Cycle is complete.

The Solar Wind

"The outer layers of the Sun's Corona are steadily blowing away right through the Solar System, in a breeze known as the solar wind. It takes about 10 days, to travel upto the Earth." Now it is found that solar wind can reach even beyond the orbit of Pluto. The Solar wind spirals out from the Sun, rotating with the Sun until it reaches a distance of approximately 100 million miles (roughly 1 AU). From that point it travels outward with less interference from the Sun's magnetic field.

The Earth's Magnetic Cage

"The Earth is surrounded by a magnetic cage, which deflects most of the electrically charged particles (that is Solar Wind) sent out by the active Sun, and stops the particles, striking the Earth directly. In effect, the Earth's magnetism makes an invisible cage, around which the solar wind flows, like a river round an island." Thus Magnetic field works as an unseen barrier to the solar wind, and protects the Earth from solar wind.

The Chromosphere

Above photosphere, there is a thin transparent layer known as Chromosphere. This layer is of indeterminate depth. It is roughly known to be 6,000 miles. The most common features within the chromosphere are Spicules, Fibrils and Prominances.

Spicules are just like long thin fingers of luminous gas, which appear as if vast field of blades of fiery grass that are growing up into cromosphere from photosphere. The others are horizontal wisps of gas that are drifting through the chromosphere and are called Fibrils. Then there are prominances, which are the most spectacular of Solar Phenomena. They are the gigantic luminous plumes of gas. They leap from the photosphere into and beyond the chromosphere, and the wonderful thing is that, they sometimes reach even the altitudes of 1,00,000 miles.

The Corona

The Corona is beyond the cromosphere and is very vast field of ionised (protons and electrons) hydrogen particles that spread out for millions of miles into space. It is so sparse that it cannot be seen in glare of the Sun. It is not visible except during

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total Solar eclipse, when the Moon passes between the Earth and the Sun, blotting out the photosphere. During the most active period of the Sun, the corona is evenly distributed around the Sun even including the polar regions. But during periods of the quiet Sun, the Corona is non uniformed and is limited to the Solar equatorial regions. Friends, it is very mysterious thing that the corona is hotter than the photosphere. In spite of its high temperature, it has a very low density and it radiates relatively little energy — coronal transients are carried by the Solar winds to the distances beyond Earth's orbit.

"How long the Sun will last? — The Sun will not last forever, although it has got an incredibly long life ahead of it. The Sun is now middle-aged. It has taken about a five billion years to use up, half of its hydrogen fuel. In the years to come it will slowly get hotter and a little larger. Over the next 5 billion years its temperature and size will gradually increase as the hydrogen is burnt. When all the hydrogen in the central core has gone, the Sun will be three times larger than it is now. On Earth the oceans will boil away. The dying Sun will swallow Mercury, Venus and Earth and turn solid rock into molten lava."

"Deep in the Sun helium atoms will combine to make atoms of carbon and heavier substances. Eventually, the Sun will cool to a ball of nuclear waste, known as a white *dwarf star, and the life of the Sun* will come to an end."

" THE SUN FACT FILE:

Mass	4.3959×10^{30} lb (1.9891×10^{30} kg.)
Diameter	870,331.125 miles (1,392,530 km.)
Rotational period at equator	26.8 Earth days
.....	at latitude 30° - 28.2 Earth days
.....	at latitude 60° - 30.8 Earth days
.....	at latitude 75° - 31.8 Earth days
Surface temperature	10,430°F
Interior temperature	26,999,540°F "

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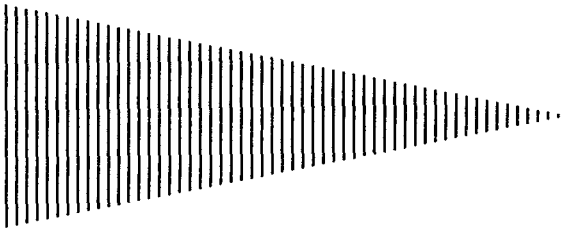
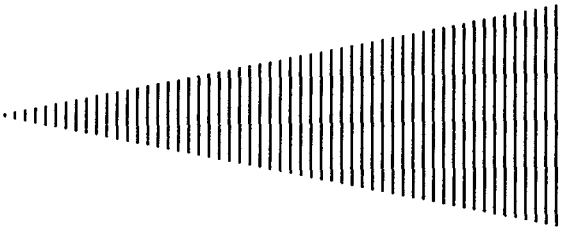


CHAPTER 5



THE MERCURY

Mercury has been visited by only one spacecraft, Mariner 10. It flew by three times in 1974 and 1975. Only 45% of the surface was mapped, unfortunately it is too close to the Sun to be safely imaged by HST.

Mercury's orbit is highly eccentric, at perihelion, it is only 45 million km. from the Sun but at aphelion it is 70 million km. The perihelion of its orbit precesses around the Sun at a very slow rate. It takes 59 Earth days for its rotation and completes each of its orbit of the Sun in 88 Earth days. Mercury rotates three times for every two of its orbits of the Sun. During one rotation on its axis Mercury completes only two-thirds of its orbit round the Sun. So Mercury takes two "Mercury years" or 176 Earth days from one Sunrise to the next Sunrise. Mercury is the only body in the Solar system that has an orbital and rotational resonance with ratio other than 1:1.

Temperature variations on Mercury are the most extreme in the Solar System, ranging from 90 k to 700 k. The temperature on Venus is slightly hotter but very stable.

Mercury is the closest planet to the Sun and the Second Smallest of the nine planets in our Solar System. It is best seen in the evening sky in spring or in predawn sky in the autumn. it is never seen in really dark sky. Because of its proximity to the Sun, it is always observed within 27 degrees of the Sun in the east before sunrise or in the west after sunset. It has a sidereal period of just three months, shortest of all other planets.

"Mercury has almost no atmosphere. Whatever gases may have been there in the past, everything has now been boiled away by the searing heat of the Sun. However, Mercury manages to catch some of the wisps of hydrogen and helium gas that blow away from the Sun."

"Also the baking hot rocks breathe out sodium atoms. So the very thin atmosphere is mainly sodium, with traces of helium and oxygen. With no air and no clouds the weather forecast on Mercury would be very simple, unbearably hot by day and at the polar regions freezing cold at night". Because of its virtually non-existent atmosphere Mercury's surface varies widely. The mid-day temperature at the side facing the Sun can be as hot as 620 degrees Fahrenheit, while at night temperature can plummet to minus 364 degrees Fahrenheit because there is no atmosphere to hold the heat. Thus temperature variations on Mercury are the most extreme in the Solar System.

SURFACE LIKE THE MOON

"Over 10,000 images of the surface were made in 1974 and 1975 by the spacecraft Mariner 10. The best photographs show craters and surface cracks as small as 100 m wide. Mariner 10 photographed nearly half of the planet. The surface is heavily cratered very like the Moon. One huge circular feature, the Caloris Basin is 1300 km in diameter. This was probably made by a crash with a large asteroid. Just as on the Moon, there are small craters shaped like bowls and larger ones with central peaks. A great many of the craters look as though, they were caused by impacts of meteorites and asteroids."

Because of Mercury's overall density, its core is thought to be largely (70 percent) composed of iron, with the surface crust being silica rock like that of the Earth or Lunar surfaces. Due perhaps to its slow rotation, Mercury has a relatively weak magnetic field despite its being composed mostly of iron.

Soon after the planets began to form, about 5 billion years ago, stray rocks, boulders and asteroids spread all through the inner regions of the solar System. They bombarded the surfaces of the planets. We can still see the results of this bombardment when we look at the Moon and Mercury. Unlike Earth these worlds have no air or water, so no erosion of their craters has taken place.

Because of its too extremity of temperature, too hot and too cold, very scanty atmosphere — almost no atmosphere — life on Mercury is not possible.

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" MERCURY FACT FILE:

Mass	0.055 Earth
Diameter	0.38 Earth, 4870 km.
Rotation period relative to stars	58.65 Earth days
Orbital period (year)	88 Earth days
Distance from Sun (average)	0.387 Astronomical units – 58 million km.
Surface temperature	maximum 430° C, minimum – 180° C.
Density	5.439/cm^3 "

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CHAPTER 6

THE VENUS

Venus is the brightest celestial object, it overshines everything in the sky, except the Sun and the Moon. It is supposed to be a very beautiful star and is named after the Roman goddess of Beauty. "It is the easiest of all the planets to spot in the sky. It's dense clouds reflect sunlight strongly making it bright, because its orbit is closer to the Sun than the Earth's. It never gets very far from the Sun as viewed from our Sky. Every seven months, for few weeks it is the brightest object in the western sky in the evening. People call it the "Evening Star." At these times it appears 20 times brighter than *Sirius*, the brightest star in the Northern sky. Three and a half month's latter it rises three hours earlier than the Sun, to appear a brilliant morning star in the Eastern sky". But it's dense thick cloudy atmosphere hides the surface from the direct view. Until the space age it was very difficult to find out the surface nature of the Venus and was sometimes called the mysterious planet.

Venus is the second planet from the Sun and Earth is next to Venus. Venus' rotation is somewhat unusual, both very slow and retrograde. It actually spins backward, in a direction opposite to its orbital motion. It takes 243 Earth days to rotate, the longest of all other planets, and it is the "Venus day". It orbits around the Sun in 225 Earth days, which is the "Venus year". Hence the Venus day is slightly longer than the Venus year. Again the periods of Venus rotation and that of its orbit are synchronized such that Venus presents its same face toward Earth when the two planets are at their closest approach.

The size, composition and mass of Venus are similar to Earth's and is sometimes regarded as Earth's sister planet. In some ways they are very similar. Both have few

craters indicating relatively young surfaces. But in many other aspects they are quite different. Venus' atmosphere is quite different from that of Earth's.

Because of its extremity to the Sun and greenhouse effect, Venus is so hot, that lead, tin and zinc would easily melt (Mercury the metal, not the planet) would boil. The rocky crust is mushy like a warm chocolate bar.

The main gases in the Earth's air are oxygen and nitrogen while Venus has a suffocating atmosphere of carbondioxide, and besides there are misty clouds of sulphuric acid. Venus and Earth both have different surfaces also. Earth has rivers, lakes, oceans and an atmosphere we can breathe and the life is there. Venus is a scorching hot planet having 900° Fahrenheit temperature; extremely hot and dry and thick atmosphere that would be poisonous to life.

The Venus surface is extremely hot, because carbon dioxide in the thick atmosphere prevents the Solar heat from escaping the surface.

Venus atmosphere has this speciality, where it acts like a green house. It traps heat from the sun and so much heat energy is trapped, that the day time surface temperature is 900° Fahrenheit, which is a global constant. The carbon dioxide, and sulphuric acid atmosphere, and dense cloud cover function as an insulating blanket trapping the heat and producing convection currents that redistributes it across the entire surface area. There is so much carbon dioxide that it crushes down with an enormous pressure, nearly 100 times greater than that of the Earth's atmosphere, and Venus has no detectable magnetic field.

Venus has some phases like the Moon which are called transits. But these are very rare which happen after 100 years and that too for a period of 8 years or so, only. Now during the period 2004 to 2012 people can see these transits, Venus orbits closer to the Sun than Earth. When Venus is on the opposite side of the Sun, the whole disc is illuminated, while sometimes very rarely, it enters in between the Earth and the Sun, and at time, we see only a part of the sunlit Venus. Thus Venus shows phases like the Moon as it travels along its orbit.

Until the space age very little was known about Venus. The swirling clouds and dense atmosphere hid the surface from view. The blistering heat and crushing atmosphere destroyed many space-crafts that tried to penetrate to the surface. In 1975 two Soviet crafts survived long enough to send back the first photographs ever taken of another planet's surface.

In 1978 two American Pioneer Venus Probes reached their target. One was Multiprobe, which released five separate probes at different points in the atmosphere.

Each gathered data and relayed its findings back to Earth, as it fell through Venus's atmosphere and eventually crashed on the surface.

The other pioneer Venus craft was an orbiter. One of its main achievement was to map 93% of the planets invisible surface by means of radar. The radar results are not as detailed as photography would be, but, plains, mountains and rolling uplands have been located, and there are circular features that may be craters. American space-craft Marinar-2 had also found that Venus has no detectable magnetic field.

The Venusian cloud cover is complete and unbroken and some water vapour is present there. The cloud layer is roughly 15 miles thick with its base about 30 miles above the surface of the planet, relatively higher than the thinner cloud cover on Earth.

" VENUS FACT FILE

Mass	0.815 Earth 4.87×10^{24} kg.
Diameter	0.949 Earth, 12,100 km.
Surface temperature	480°C (maximum)
Rotation period relative to stars	243 Earth days
Orbital period (year)	224.7 Earth days
Distance from Sun (average)	0.723 Astronomical units, 108 million km.
Density	5.25 g/cm^3 "

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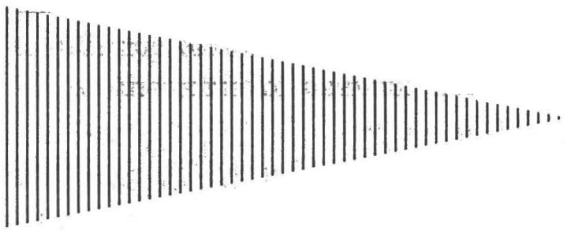

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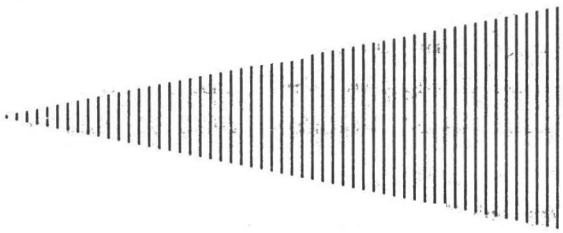

THE EARTH

The Earth is the third and the largest terrestrial planet in our Solar System. There are nine planets and the Sun. The planets never leave their orbits, all of them are controlled and balanced by their gravitational force. The Sun is the center and main figure, and has much greater gravitational force than all other planets have together. And so, the Sun is like the king of the Solar System. But even then, our Earth has its own peculiar – speciality that no other body in our Solar System has. Our Earth alone has life on it, and that too an intelligent life like human being, alongwith so many, numerous other species of life.

The Earth was formed at the same time when our Solar System was formed, that is at about 4.6 billion years ago. At that time the Earth was probably solid throughout. Then over a period of millions of years later, radioactive decay heated the Earth and gradually metallic material melted and separated from non-metallic silicate material and then it sank toward the centre of the Earth and the silicates floated up. This molten metallic material is today also there as the Earth's core, which consists mostly of iron and nickel. The core is about 4200 miles in diameter and the temperature at the core is approximately about 11,000 degrees Fahrenheit. The outer core is mostly molten while the inner core is solid one. The continuous motion of the molten core makes magnetic field of the Earth. Outside core is the layer known as the mantle composed of solid and molten silicate rock. It is roughly 1800 miles thick. Above this mantle there is a thin crust which varies from 25 to 5 miles only.

The Earth's major continents or land masses are in order of size – Eurasia (21.3 million square miles), Africa (11.7 million square miles), North America (9.4 million square miles), South America (6.9 million square miles) Antarctica (6.0 million square

miles), and Australia (3.0 million square miles). Prior to 2 million years age the continents were combined in a single massive super continent called Pangaea. Then in course of time, some parts of mass of land drifted away from the Pangaea and by continental-drift that the continents came into their present position on the Earth's surface, and it would be by this same process that the continents would continue to move apart.

The continents, however, are merely the uplands of the Earth's Crust and together they comprise less than a third of the Earth's total surface area. Approximately 70 per cent of the crust is covered by water in the form of four major oceans and a number of smaller bodies known as seas, rivers and lakes. The four major oceans are in order of size – The Pacific (64 million sq. miles), the Atlantic (31.8 million sq. miles), the Indian (25.3 million sq. miles) and the Artic (5.5 million sq. miles).

As compared to inner terrestrial bodies and Earth's own Moon, the surface of the earth is smooth. It is because of the Earth's atmosphere the winds and water and even ice. there is always erosion on the Earth's surface. It keeps the surface more or less even. All these aspects carry things from one place to another and wear away rocks and soil – this is erosion. And over millions and thousands of years erosion can make less the effects of meteor impact craters can move mountains, dig out and fill in valleys and can change the directions of the rivers also. And thus the Earth's surface becomes more or less even, having changes throughout the millions of years.

Above the surface of the Earth is, its Atmosphere which is comprised of several layers of gasses, roughly 120 miles thick and weighing 5,700 trillion tons, composed primarily of Nitrogen (78%) and Oxygen (21%), the Earth's atmosphere is divided into five layers. The troposphere is the densest and closest layer, covering the Earth to a depth of seven miles. Next are the stratosphere or ozonosphere (7 to 30 miles). The mesosphere (30 to 50 miles) and the ionosphere (50 to 150 miles) Roughly 80% of the Earth's atmosphere molecules and most atmospheric pressure are concentrated in the troposphere. The atmosphere becomes much thinner above the mesosphere, so that 120 miles is generally recognized as the edge of outer space. The Earth's atmosphere serves to shield the planet from much of the Sun's radiations. The visible spectrum penetrates all the atmospheric layers, but infrared and radio waves are practically blocked by the stratosphere. Ultra violet radiation is almost entirely blocked by a layer of ozone in the stratosphere and x-rays do not penetrate the atmosphere. Thus it is because of Earth's atmosphere only, that life on the Earth has become possible. All the living beings should be very grateful to the Sun because, only because of Sun's light and heat the living beings have their lives. Again the Earth's atmosphere acts as a modulator of temperature. If the Earth had been slightly warmer, there would have been the same green house effect on the Earth, which the Venus

is suffering, and our Earth would have a carbon dioxide atmosphere today also and life would not have been possible on Earth.

The composition of the Earth's atmosphere is the same at all altitudes, upto 60 km. from ground. The clouds of water vapour are concentrated only in the troposphere. At any given moment, half the Earth's surface is covered with clouds. The Earth's cloud cover is constantly moving in global weather pattern. The Earth's water is being recycled through the clouds. When clouds encounter cold air masses, water falls to Earth, in the form of rain (liquid), snow (crystalline solid) or occasionally as hail (solid). Once on Earth, it follows into streams, and from there to rivers and ultimately into the Oceans and other large bodies of water from which it evaporates back into the atmosphere to once again form a cloud.

The Wind is the air, moving from one place to another. Air always moves from where the pressure is high to where the pressure is low. Warm air weighs less than cool air. Air currents always move from cool air to warm air. When there is a great difference between the levels of these two pressures, the winds movements are very strong. The weather can sometimes be very dangerous. Violent storms can create fierce twisting winds that seriously damage anything that comes in their way.

During certain seasons cyclonic storms (typhoons in the Pacific or hurricanes in the Atlantic) characterized by high winds can form in the Earth's cloud cover.

● DAY AND NIGHT

Every day the sun rises over the Eastern horizon. It starts climbing higher and higher in the sky getting overhead at 12 noon. Then it starts descending and in the evening it sets in the west and nightfall soon follows. This is the every day cycle. But what does it make to behave in this way? It is because of the Earth and the Sun, only. As we know that the Earth orbits round the Sun and at the same time, it rotates on its own axis also. Earth is like a spinning ball turning from West to East. Earth's one day's rotation makes the Sun appear to move across the sky. The side of the Earth facing the Sun has a day, at the same time, on the other half of the Earth facing away from the Sun, it is night.

We say, it takes a year for the Earth to go round the Sun, but it is not a year of exactly 365 days. The precise length of a year, say from one midwinter's day to the next is 365.24219 days. If we did not put it in a leap day every four years, the seasons would soon be out of step with the months and that would be very inconvenient, to match the year even more accurately with our calendar, the rule says that year ending in '00' such as 1900 are not leap years unless they are exact multiples of 400. So the year 2000 is a leap year but 2100 will not.

Before clocks were invented most people had to rely on the Sun for keeping the time. However if everyone took the time directly from the Sun, a serious problem would arise. Sun-time readings differ for places with different longitudes. Longitude is measured in angular degrees East and West of Greenwich England. For each 15° of longitude, the Sun time changes by a whole hour. All the people living in one country or area need to agree on just one time to follow, if there is not to be a great deal of confusion. The time taken directly from the Sun is called local time, and that agreed for a whole country or area is called standard or civil time.

"Each night there is a small but noticeable change, any particular star rises about four minutes earlier than it did the previous night. As the Earth spins in space while orbiting around the sun, the length of time it takes a star to get back into the same position in the sky is only 23 hours 56 minutes and 4 seconds. This short day is called the sidereal day — sidereal means to do with the stars."

Each year the Earth travels one complete circuit of its path or orbit around the Sun. On the round trip, the Earth and every thing on it is speeding at 70,000 miles per hour. People do not feel any sensation of the high-speed motion, because they keep moving smoothly at the same rate. Although the Sun is average of 93,000,000 miles away from the Earth, there is a strong gravitational pull between the two bodies. This gravitational force attracts the Earth toward the Sun but the Earth's speed in its orbit prevents it from falling in toward the Sun. Instead it orbits the Sun. The Earth's orbit is very nearly a circle. It is slightly elongated — a shape called an ellipse, and the Sun is nearer the one side of the Earth's orbit. The Earth is about 3,000,000 miles nearer the Sun in January, when it is closer than it is July, when it is at its farthest point from the Sun. The difference in distance causes only a very slight change in warmth of the Sun's rays, much smaller than the familiar seasonal changes.

The stars visible at night are different from season to season. Each night the stars rise above the horizon about four minutes earlier than they did the previous night. After an interval of fifteen days the stars are rising and setting a whole hour earlier. Over the period of six months, the stars rising times change by twelve hours, consequently night sky of winter looks completely different from the pattern of stars visible in the summer. When a whole year has passed, the same familiar stars once again become visible. Although, the weather may be quite different from year to year, the changes in the sky are the same.

Note: The sentence/para in inverted comas indicate that the said sentence/para is/are taken from *The Young Oxford Book "Astronomy"* by Simon and Jacqueline Mitton, London, UK.

If the Earth's axis were at right angles to its orbit, there would be no seasons. In fact, it is slanted by 23-1/2° and so the seasonal changes occur. "When summer comes to the Northern half of the Earth, the North Pole is tilted toward the Sun. The Sun gets overhead at more northernly latitudes each day until about June 21. On this, day which is properly called the summer solstice, the sun stands overhead at the tropic of cancer, latitudes 23-1/2° North. The summer solstice is the longest day whereas the winter solstice is the shortest day. The situation is vice-versa in southern hemisphere. Seasons of the South are exactly opposite to the North." Throughout the Earth's annual seasonal cycle equator receives more sunlight than any other part of the planet, while, the poles receive the least. And so the Earth's poles have permanent ice caps, which recede slightly with the warmer season.

Places inside the Arctic circle (latitudes 66-1/2° to 90° north" experience some days, when the sun never sets, these places are tilted toward the Sun. The countries in the far north are called "The land of the Midnight Sun." In the summer there is light for the out-door sports at midnight. In winter, however the situation is vice-versa, the long hours of summer day light have to be paid for."

"While the far north endures the long winter nights, the South hemisphere enjoys its summer. The Sun has moved southward in the sky. At the fall enqinox about September 23, when day and night are of equal length, it is overhead at the Equator. But later on the North Pole tilts away from the Sun, the south pole turns towards it. The winter solstice for north occurs on the same day as the summer solstice for South about December 21. The Sun is overhead at latitudes 23-1/2° South, called the Tropic of Capricorn. When the next equinox comes on about March 21, the north experiences spring, while the fall comes to the South and the Whole cycle starts once again. On these days the Sun is overhead on the Equator, and days and nights are of Equal size, that means, 12 hours and these days are called Equinoxes". On these days the Sun is over head on the equator and days and nights are of equal size, that means of 12 hours, and are called the Equinoxes. Thus, it is because of the Earth's tilted axis only seasons happen to be there. If it would have been at 90°, there would have been no seasons.

We can say where any place is, on the Earth, by giving its latitude and longitude. Latitude is measured in degrees 0° to 90° north and south of Equator and Longitude is measured in degrees from 0° to 180° east and west of circle chosen to go through the North and South poles and with Greenwich England being at 0° longitude.

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● LIFE ON EARTH

"While life on the Earth is thought to have originated at two and half billion years ago, its development is traced from a point 550 million years ago at the start of the Cambrion period. It is from this period that the oldest fossil evidence of life is found. After a very long period, millions of years or we can say in due course of time, the two forks of the road of life, as we know it began, these two forks of the oxygen breathing animal kingdom and carbon dioxide breathing plant kingdom — became the two mutually interdependent life forms that have been perpetuated by their own symbiotic relationship for the past several million years.

After this, life on Earth was developing for a vast period of millions of years. Various types of plants and animals were there during this era. And now came the current period of Holocene, this new upright walking species have come to be Earth's dominant species. Beginning quietly in the Africa / Eurasia area, and gradually spread throughout the world, humans were the first animals to use tools, conduct wide spread domestication of other species and to record their own history in the variety of spoken and written languages". Roughly 40 years ago humans became the first species to build tools and carry themselves away from the Earth to other bodies in The Solar System.

" EARTH FACT FILE:

Mass	12.1×10^{24} Lbs
Diameter	7926 miles (12,756 km.)
Rotation period	23.93 Earth hours, 23 hours 56 min.
Orbit period	365.24219 Earth days, a year
Distance from the Sun	94,240,000 miles
Distance from the Moon	2,38,000 miles, 3,80,000 km. "

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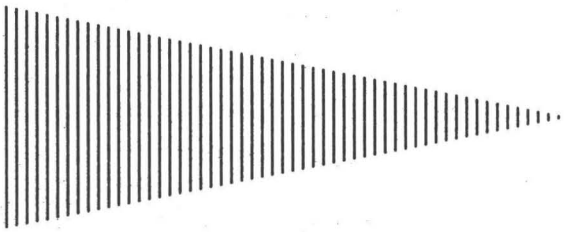

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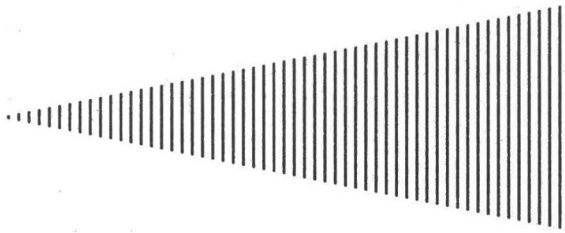

THE EARTH'S MOON

The Earth is the only planet in the inner Solar System, with a large Moon. Both are like a pair and held together by their force of gravity. The Earth has 81 times the mass of the Moon. The Moon is 27% the size of the Earth.

The Moon travels in an orbit around the Earth taking about a month. During the course of a month the Moon goes through its regular cycle of phases. The Moon always keeps the same face towards Earth, as its rotational and revolutional period around the Earth is the same. This combination of motion is called "Captured Rotation".

The Moon appears to go through a series of phases depending upon its reflection of light from the Sun. These phases which constitute a Lunar day, go through a complete cycle every 29 days 12 hours 44 minutes, which is known as the Lunar month.

When the Moon is fully illuminated, it is said to be "full". As the visible phase of the Moon rotates away from the Sun, it is said to be "waning". When exactly half the face of the Moon is illuminated, it is called a "quarter Moon". As it becomes less visible, it is said to be a "crescent Moon", and when it becomes dark, it is said to be a "new Moon". From "new" the Moon waxes to the crescent phase to the quarter phase, and once again to the "full Moon". The Sun always illuminates one half the Moon. Depending upon the relative angle between the Earth and the Moon, we see portions of the Moon's Sunlit side. At "full Moon" we see entire Sunlit side and at "new Moon" none of the Sunlit side is facing the Earth.

"Because of the Moon's slight wobbling, we are able to see slightly more than half of its surface from Earth. Though the 41 per cent of Lunar surface, that is never

visible from Earth, is frequently referred to as the "dark side", it actually receives as much light from the Sun, as the "near" side. When the Moon is perceived as "full" on Earth, the far side is in fact "dark", but as the near side gradually wanes, the Moon waxes on the far side and vice versa".

The Moon's surface is full of rugged mountain ranges and thousands of materials impact craters. The Moon has large open areas that are called seas (Maria) because to the unaided eye they appear darker than the surrounding terrain, and once thought by Galileo to resemble the seas. The Maria cover is the 15 per cent of the Lunar surface, and were probably once "seas" of molten rock that flowed out of the Moon's interior. It is probably because of the gravitational effect of the Earth, the Marias are concentrated on the Earthward side. The Moon has neither magnetic poles nor significant magnetic field, although rocks in the Lunar crust are weakly magnetized. Probably because of its low mass and density the Moon never developed an atmosphere. The Apollo programme studies revealed that the Lunar interior was quite active with moonquakes, being more common on the Moon than earthquakes are on the Earth.

The Moon was formed about the same time as the Earth, 4.6 billion years ago – and it is composed of the same basic materials, but the early Earth/Moon relationship is unclear. One line of thought theorizes that the Moon was formed out of Earth either in a single piece that broke loose (perhaps from the Pacific Basin) or in the form of debris that was left behind in a collision with an asteroid, and which eventually congealed into the Lunar mass. Another theory is that the Moon was a separate planet "captured" by the Earth's gravitational field. A third notion is that the Earth and the Moon were formed, in the same way and in the same place and time. Because the Earth was 81 times larger, the Moon became enslaved to its gravity.

Once in place, the Moon's geology evolved much like that of the Earth. Originally molten, the crust gradually cooled leaving a molten core like that of the Earth. In the meantime the crust was also being bombarded by debris from the formation of the Solar System.

In addition to smaller craters, huge basins were hammered into the surfaces of both the Earth and the Moon. At 3.85 billion years ago, the Lunar surface was probably pocked entirely and uniformly with impact craters. The semi-circular Mountain ranges found around the periphery of the Maria are the only remnants of the enormous impact that created them. During this period, however, intense interior heating resulted in vast flows of darker basalt from deep within the Moon. Part of the heating came from meteor impacts and, part from radioactive decay. These flows filled the huge basins and the Lunar seas in short are seas — of Lava!

Throughout the billion of years the Moons' surface has remained relatively unchanged, because there is no air, no wind and no water, to cause erosion of the type that has greatly altered the surface of such bodies mainly as the Earth, and to some extent Mars.

"Thus Moon has no atmosphere, its sky is always dark even in day light because there is no air to scatter Sunlight and create the blue sky as we have on Earth. Sound waves cannot travel in the vacuum and so the Moon is completely silent, there is no weather. During the Lunar day the surface temperature in direct Sunlight, goes well above the boiling point of water. Humans who explore the Moon wear airconditioned space suits for protection from the intense heat. At night the Moon's temperature plunges to 150°C below freezing".

"Tides are familiar to anyone who lives near or visits the coast. Twice a day level of ocean rises and falls in some places by a very considerable amount. Each day the tides come about 50 minutes later. The Moon is responsible for this. The Moon keeps orbiting the Earth, because the two bodies are held together by the pull of gravity each has on the other. All the time the Earth is tugging at the Moon and the Moon pulls at the Earth".

"Because the oceans are liquid and can flow, they are easily distorted by the Moon's gravity into a lemon shape. The rocky ball of the Earth stays in the middle. The result is a bulge of water on the side of the Earth towards the Moon, and another bulge on the opposite side. As the solid Earth spins, the coasts experience high and low tides twice in a period of 24 hours 50 minutes when they pass through the water humps. This time is longer than 24 hours because the Moon itself is moving along its orbit as well. In bays and river estuaries the rise and fall of the tides can be greater than in other places as the sea water is tunnelled into narrow channels".

"As well as the Moon, the Sun also contributes to the height of the tides. When the Sun and the Moon are lined up so their gravitational pulls are in the same direction and reinforce each other, there are higher tides than average, called spring tides. This happens at New Moon and Full Moon. When the Sun and the Moon are pulling at right angles, they partly cancel out each others' effect and the tides are lower than average. These are neap tides and they occur when the Moon's phase is First Quarter or Last Quarter".

In 1968 the United States began the Apollo project, a series of space flights during which the Moon became the first body in the Solar System beyond Earth to be explored first hand by human beings.

Note: The sentence/para in inverted comas indicate that the said sentence/para is/are taken from *The Young Oxford Book "Astronomy"* by Simon and Jacqueline Mitton, London, UK.

The Moon was surveyed by human being from Lunar orbit for the first time by means of two circumlunar manned flights in December, 1968 and May, 1969, which began the operational phase of the Apollo programme.

In July, 1969 the Apollo 11 space craft became the first vehicle to land human beings on the Moon. Neil Armstrong and Edwin Aldrin Jr. were the first Astronauts to step on the Moon. This initial landing was followed by five others between November, 1969 and December, 1972. A 7th mission was aborted because of hardware failure in April, 1970.

During the Apollo programme, 12 American Astronauts conducted detailed surveys of the Lunar surface and seismic studies of the Lunar interior. The Apollo programme completed detailed mapping of the Moon and provided a wealth of information about its composition and its geologic history.

NEWS

Confirmation of the Origin of the Moon

There were three four theories about the origin of the Moon. Both the Earth and Moon are composed of the same basic materials. Even then, the relation of both was not clear. But now, the relation has been confirmed, as the origin of the Moon is confirmed. Somewhere in the middle of the year 2001, *appeared in the Times of India, Mumbai Edition,* there was this news confirming the origin of the Moon.

They have confirmed the theory that Moon was formed out of Earth, the matter in the form of debris that was left behind in collision with an asteroid and which eventually congealed into the Lunar mass.

" MOON FACT FILE:

Mass	0.0123 Earth, 7.35×10^{22} kg.
Diameter	0.273 Earth, 3476 km.
Distance from the Earth	380,000 km.
Rotational period and)	29 days, 12 hours,
Revolutional period is the same)	44 Minutes "

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CHAPTER 9

THE ECLIPSES OF THE SUN AND THE MOON

The Sun is 109 times the diameter of the Earth and at a distance of 93 million miles. The Moon is only one quarter the size of the Earth, but it is 390 times nearer than the Sun and 390 times smaller. Of course, things look much smaller when they are at a great distance than when they are close by. The difference in distance, compensates for their difference in size. As a result, the Sun and the Moon appear to be very nearly the same size. When the three celestial bodies lie in a straight line, it is called Syzygy. At the time of eclipses, the Sun, the Moon and the Earth lie in the same way, called Syzygy. If the moon's shadow falls on the Earth, a solar eclipse occurs.

"Every month, at New Moon, the Moon goes between the Sun and the Earth in space. But the exact line-up, we need for an eclipse is not always there, two or three times a year on the average the Moon's path takes it directly between the Earth and the Sun. At such times an eclipse of the Sun takes place". The dark disk of the Moon blots out all or part of the Sun for a short time. A total eclipse of the Sun must be one of the most eerily beautiful sights in nature. Only a **remarkable coincidence** makes it possible for us to witness this spectacle.

Most Solar eclipses are not total and even when they are the full spectacle of totality, can only be seen over a very small area of the Earth's surface because the Moon's shadow cannot measure much more than 100 miles across on the Earth's surface, and as it speeds along its orbit the shadow sweeps out a long curved path on the Earth. Any eclipse of the Sun could be seen only by people who are somewhere along this long and relatively narrow (path) track.

At any one place the totality lasts for as little as a few seconds to as much as almost eight minutes. The eclipse starts when the Moon first edges over the Sun's

disc. During this time the eclipse is only partial. Gradually more and more of the Sun is covered and the Sun's crescents are seen and if it is total eclipse, it lastly reaches to its totality. But in a certain area on each side of the eclipse track, only a partial eclipse can be seen.

As the total Solar eclipse becomes imminent the sight also becomes very dramatic. The sky darkens and the stars appear and air temperature falls as if there is night. When the Sun's disk is completely blotted out, a shining white halo shimmers around the black Moon. This is the Sun's corona a crown of thin hot gas steaming away from the Sun. It can be seen only when total eclipse is there. Because the corona is so sparse that it is not visible against the glare of the Sun.

The edge of the Moon is not perfectly smooth because there are mountains and valleys running along it. Just before or just after totality, the Sun may shine through these valleys. This gives the impression of a string of pearls or a flashing diamond ring.

Because the Earth and the Moon have elliptical orbits, the distances between the Sun and the Earth, and between the Earth and the Moon are not constant. When the Sun is closer than usual and the Moon is more distant than usual the Moon looks a little smaller than the Sun. If an eclipse then occurs, the Moon does not cover the Sun completely. Instead a bright ring of Sunlight circles the black Moon. Such an event is called an annular eclipse, the Latin word annular means ring. During the annular eclipse the sky remains bright and the corona cannot be seen.

The Earth itself also cast's a long shadow through space, cutting out the light of the Sun. The Earth's shadow has two parts umbra and penumbra. Umbra is the inner, dark and small part, whereas penumbra is outer, faint and quite big part of the shadow. When the Moon is travelling through the Earth's shadow, we can see Lunar eclipses, both partial and total. When the Moon travels into a part of this shadow, it is a partial Lunar eclipse, and when all of the Moon travels through the umbra also it is a total Lunar eclipse. Here the Moon moves the whole shadow of the Earth, first entering penumbra then umbra and them other side of the penumbra, and then it moves out of the Earth's shadow, and the total eclipse is over, it can last upto 1 hour 44 minutes maximum.

While being under the eclipse, Moon can still be seen with a dull coppery light. While this journey of the Moon, the Earth is in between the Sun and the Moon, and the Moon is in the Earth's shadow. Now though the Moon is in the Earth's shadow, it is lit by a small amount of Sunlight, scattered in its direction from the Earth's atmosphere. This is why, even when there is Lunar eclipse the Moon has small amount of coppery light.

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CHAPTER 10

THE MARS

Mars is the next planet out from the Earth, in the direction away from the Sun. It is known as "Red Planet" because of its distinctive iron oxide coloration. Early Roman observers always compared the Stars and Planets in the sky with their Gods or Goddesses. Mars reminded them a distant bloody battle field, and they named it "Mars" after their god of war.

Venus may be the Earth's near twin in terms of size, but Mars has more specific characteristics in common with the Earth than any other planet.

The Mars' orbital period that means Martian year is of 687 Earth days which is near to 23 Earth's months, about double the Earth's year which has 12 Earth's months in the year. Rotational period of Mars is 24.6229 hours, so the Martian day is only 41 minutes longer than the Earth day. Mars' inclination to its rotational axis 24 degrees, which is very close to Earth's 23.4 degrees inclination on its axis. Hence, the Mars has four seasons parallel to that on Earth. Its summer is relatively warmer than winter having occasional light snow or frost. Apart from Earth, Mars is the only planet in the Solar system which has polar ice caps, and they expand and recede seasonally like those of Earth. South polar cap is composed of water ice and also the carbon dioxide ice (dry ice) where as North polar is composed only of water ice and tresses of carbon dioxide snow that evaporates in summer.

Mars is smaller and less dense than Earth, and naturally it has less gravity, much thinner atmosphere than Earth, and is also colder than the Earth and has in its polar regions temperatures rarely rising above minus 200 degrees Fahrenheit and the mid-summer temperature near the equator can reach comparatively very comfortable 80° Fahrenheit which is close to an Earthly temperature range that cannot be found in any where else in the Solar system.

The rust-red Martian surface indicates the global high concentration of iron oxide in soil and rocks. The surface of Mars is covered by volcanic impact craters that are found on Mercury and the Earth's Moon. Other features common to other bodies in the inner Solar System are faults, rifts, and seismic features zones. In addition to craters and rift canyons, the Martian surface is marked by vast network of dry river beds, huge channels cut by steams of running water. There is no liquid water visible at any place on the surface of the planet nor is Mars' atmospheric pressure high enough to permit it to exist. Yet the river beds are the witness to the fact that a great deal of water may have once flowed there.

From the Viking photographs scientists have found that, when the Solar System was formed, Mars was probably like the Moon (Earth's) and Mercury. For the first billion years or so Mars and other planets were often hit by meteorites which have left numerous craters on the surface of Mars.

"When the planets formed, they were all much hotter than they are now, today. Mars cooled down more quickly than the Earth, because it is smaller. We know that Mars was hot enough in the past to have a liquid interior, because there are many volcanoes. Near the region of equator of Mars there are the stupendous volcanoes in the Tharsis region, Tharsis is the name astronomers have given to a bulge on the planet 4000 km. across and about 10 km. high. This planet has four volcanoes, each of them gigantic compared to any on Earth. They are known as shield volcanoes and were made from very runny lava that spread far and wide before going solid. About 2/3rd of Mars consists of high lands with many impact craters surrounded by debris. In these region there are branching valleys and land slides. Around the equator, near to the Tharsis volcanoes, there is Mariner valley 600 km. wide and very very Deep. Long ago the surface layer of Mars seems to have been quite wet and valleys show signs of water erosion." The straight walls of Mariner valley suggests that the whole region is a giant crack or fault in the crust of the planet.

Like that of Venus the Martian atmosphere is almost entirely composed of Carbon dioxide, with traces of nitrogen, argon and oxygen. Martian atmosphere has distinct North-South weather pattern, that cross equator. Mars has much less cloud cover than the Earth's roughly 50 per cent coverage, but the cloud types are similar. These include cirrus and gravity wave cloud as well as cyclonic storms that on the Earth would be referred to as hurricane or typhoons. While most of the Martian cloud cover is composed of water vapour (like the clouds of the Earth's atmosphere) carbon dioxide clouds exist at high altitudes and in the polar regions during the

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winter. While the carbon dioxide that is present in the ice caps as dry ice vaporizes and circulates within the Martian atmosphere, polar temperatures are such that most of water ice present in the Martian ice caps remains frozen continuously even in summer.

Winds that are raised as a result of atmospheric circulation and seasonal or daily temperature fluctuation can result in huge dust storms in the Martian atmosphere.

Upto the space age, it was supposed that Mars has a life and may be an advanced like ours. But when American space probe Marinar 4 produced the first clear pictures of Mars from close-up, they showed a lifeless world shattered by craters.

"In 1975 U.S. scientists launched two Viking space-craft. Each carried a lander and an orbiter, which photographed Mars in detail. Every thing that we know about Mars, came from these explorations, which lasted for more than four years. Through these explorations no evidence was found of plants or animals and the chemistry experiments failed to find the kinds of molecules associated with life. Thus Mars is almost certainly a dead world now, but even then we cannot know whether it had primitive life long ago, without further exploration."

'Mars has two Moons named Phobos and Deimos. These two Moons are so small that it is very hard to see them even with a large telescope. Phobos is about 23 km. across and Deimos is only 16 km. These two have several craters and may be asteroids that Mars has captured because they have very much similarity to asteroids. Both look like the sorts of rock lumps, that formed in the early Solar System.

" MARS FACT FILE

Mass	0.107 Earth, 6.4×20^{23} kg.
Diameter	0.53 Earth, 6670 km.
Rotation period relative to stars (day length)	24.6229 hours.
Period of Orbit (year)	687 Earth days.
Distance from the Sun (average)	1.5237 Astronomical Units 228 million km. "

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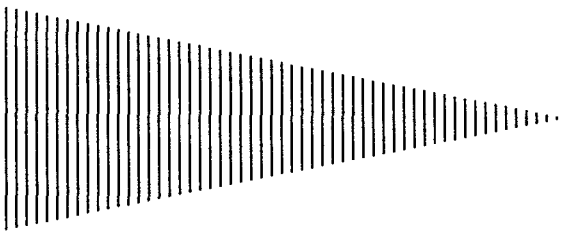

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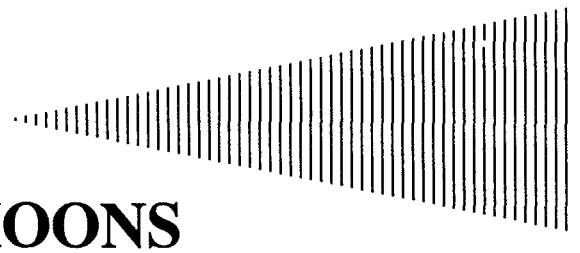

THE JUPITER AND JUPITER'S MOONS

Jupiter is the largest planet in the Solar System and is second in mass except only to the Sun itself. We have seen that early Roman observers always compared the stars and planets in the sky with their Gods or Goddesses. Jupiter is the name of the King of all Roman Gods. Among all planets, Jupiter is great in all respects and the Romans have named it after the King of Gods.

Jupiter has 1330 times the volume of the Earth and 318 times the mass. While the Solar system was being formed, Jupiter may have had the makings of becoming a star. At that times Jupiter had 10 times bigger diameter than it has today, and was heated by gravitational contractions. If the nuclear reactions with Jupiter would have become self sustaining like the Sun, Jupiter may have blazed like a second Sun. And the two objects may have become a double star, and the solar system would have been vastly and totally different, than it is today. But Jupiter failed as a star, and it gradually began to cool and collapse to its today's size. As it cooled, it started becoming less and less brilliant and after a million years, "Jupiter that might have been a star" lost its luminosity so much that it went from one hundred thousandth the luminosity of the Sun to one ten billionth. Even then, today more energy is radiated from Jupiter itself as it receives from the Sun. Jupiter's magnetic field is more than 1000 times greater than the Earth, and so the leading observers can postulate the existence of metallic core.

Jupiter is a huge ball of gas like Sun and there are three other giants – Saturn, Neptune and Uranus, next to Jupiter and there is a vast distance between each other. These gaseous planets are similar to Sun in their chemical make-up and are totally different from inner terrestrial and rocky planets. Jupiter's atmosphere is

composed, almost entirely of hydrogen and helium, which means that of gasses and fluids, without solid surface. Even though we cannot see a rocky surface, deep within the planet, hydrogen is crushed so much that it gets some of the properties of metal and it becomes liquid metallic hydrogen. Thus there is a sea of liquid metallic hydrogen that makes up the bulk of Jupiter, and hydrogen then behaves like metal, it conducts electricity easily and the electricity flowing in the metallic hydrogen, produces a strong magnetic field round Jupiter.

"Jupiter rotates very rapidly, one every 10 hours. This is so fast that the planet bulges at the equator. The rapid rotation also causes high wind speed in the upper atmosphere, where the clouds are stretched out into colourful bands. Different parts rotate at slightly different rates and these speed differences cause the bands. The clouds are turbulent and the appearance of the bands can change in just a few days. There are also a great many whirlwinds around spots in Jupiter's cloud. The largest of this is the Great Red Spot, which is larger than the Earth. It is visible through a small telescope. The Great Red Spot is a huge storm in Jupiter's atmosphere, which has been observed for over 300 years".

Jupiter's atmosphere is complex and dynamic, characterized by distinct horizontal 'belts' or darker bands of clouds, that exist in the Northern and Southern hemispheres and which alternate with lighter coloured "zones". The dark reddish bands on Jupiter are called "belts" and the light coloured bands are "zones".

The photographs taken by the astronomical instruments show that there are noticeable changes in the belts and zones in a few weeks. This is because – the features we can see are in fact coloured and white clouds in the upper atmosphere. In the vicinity of the Great Red Spot, the clouds form beautiful whirlpools and wave patterns. The swirling clouds are blown along by winds of over 500 km. per hour.

"Most of Jupiter's atmosphere would be deadly to humans. In addition to abundant hydrogen and helium, there is methane, poisonous ammonia, water vapour and acetylene. You would find it a smelly place. These gases are similar to those from which the Sun formed."

The white cloud contains crystals of frozen ammonia and frozen water. The brown, red and blue clouds may be coloured by chemicals similar to dyes or by Sulphur. Lightening storms flash through the outer atmosphere.

"The active cloud is quite thin, less than one hundredth of the planet's radius. Beneath the clouds the temperature rises steadily although it is - 160° C at the cloud

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tops. Only 60 km down through the atmosphere, temperature is as high as on the surface of the Earth. Just a little further in, and the temperature of the boiling point of water is reached".

"Jupiter emits more energy then it receives from the Sun. Spacecraft measurements have shown that Jupiter radiates about 60 per cent more in heat energy than it gets from the Solar radiation. The extra heat is believed to come from three sources, heat still remaining from the formation of Jupiter, energy released by the slow contraction of the planet and energy from radioactive decay. However, the heat does not come from burning hydrogen into helium, which is, what stars do. In fact the smallest hydrogen burning stars are about 80 times massive than Jupiter. Jupiter is a radio station but you cannot make any sense of Jupiter's radio signals because they consist entirely of noise. Electrons whizzing through Jupiter's huge magnetic field, make the radio signals. Immense thunderstorms and flashes of lightening add to the radio din. Jupiter has a strong magnetic field, which extends to 50 Jupiter diameters from the Planet. No other planet in our Solar System has such a strong magnetism and radio emission".

" JUPITER FACT FILE:

Mass	318 Earth, $1{,}910^{27}$ kg.
Diameter at the equator	11.2 Earth, 143,760 km.
Rotation Period	9.93 hours
Period of Orbit (year)	11.86 years
Distance from the Sun (average)	Astronomy 5.203 astronomical units, 778 million km. "

Note: The sentence/para in inverted comas indicate that the said sentence/para is/are taken from *The Young Oxford Book "Astronomy"* by Simon and Jacqueline Mitton, London, UK.

JUPITER'S MOONS

Jupiter has 28 Moons altogether, and it looks like a Solar System in miniature with Jupiter as the Sun and all its moons as Planets. Jupiter's moons are called Jovian Moons. All these moons are organized into a very orderly system of four dissimilar groups, each comprised of four similar sized moons orbiting in distinctly different planes.

1. The inner group (except for Amalthea) were all discovered during the Voyager project, and they have diameter of less than 200 miles. They all orbit in a plane whose orbital inclination is less than half a degree and they are located less than 1,40,000 miles from Jupiter.
2. The Second group called "The Galileans" were all discovered in 1610 by Galilieo Galilei (1564-1642) and they have diameters greater than 1900 miles. They all orbit in a plane whose orbital inclination is less than half a degree and they are all between 250,000 and 700,000 miles from Jupiter. They are the largest moons, not only in Jovian moons but also among the Solar System.

   All the Galilean moons are – lo, Europa, Ganymede and Callisto. lo takes just under two days, Europa three and half days, Ganymede a week and Callisto almost seventeen days for one trip around Jupiter.
3. The third group were all discovered in the 20th Century prior to Voyager and they all have diameter of less than 105 miles. They all orbit in a plane, whose orbital inclination is between 26 and 29 degrees and they all are between 6.9 to 7.2 million miles from Jupiter.
4. The final group was discovered in the 20th Century prior to Voyager and they all have diameter of less than 17 miles. They all orbit in a plane, whose orbital inclination is between 147 and 163 degrees and they are all between 12.8 and 14.7 million miles from Jupiter.

   The inner group of Jovian moons is dominated by Amalthea, discovered in 1892 by Edward Emerson Bernard. (1857-1923)

● GALILEAN MOONS

1. Ganymede is the largest moon in the Solar System, having diameter of 5262 km. It is covered in a thick crust ice, which lies over a rocky core. There is plenty of evidence of bombardment by meteorites as well as a giant impact from an asteroid.

2. Callisto is nearly as large as Ganymede, and has heavily cratered surface, yet encountered in the Solar System. Because of the crowding cratered surface the appearance of Callisto has remained unchanged, comparatively for several billion years.
3. Europa has the brightest surface, it is one-fifth water which has formed a coating of ice 100 km. thick. This reflects the light as well as the clouds and its surface appears to be very bright.
4. lo – The most spectacular moon is the lo, orbiting close to Jupiter. Lo has an extraordinary colour, a mixture of black, red and yellow. Its unusual colours are caused by sulphur that has spewed out of lo's interior.

   The other Moons are orbiting the Jupiter but are very small and four among them are even closer than lo and are believed to be large lumps of other satellites that no longer exist. The miniature moons orbiting far from Jupiter are probably asteroids that strayed too near to Jupiter and got trapped in its gravitational field. All of them have not been photographed in detailed.

   Jupiter also has three very faint rings first discovered by voyager 1. These rings are made up of tiny particles of dust. The Jupiter's rings are very thin and narrow and are not visible except viewed from behind the night side of the planet when they would back lighted by the Sun.

   The names of other 12 Moons. (4 + 12 = 16) + 12 New Discovery = 28

" 5. Adrastea
6. Amalthea
7. Thebe
8. Metis
9. Leda
10. Himalia
11. Lysithea
12. Elara
13. Ananke
14. Carme
15. Pasiphea
16. Sinope "

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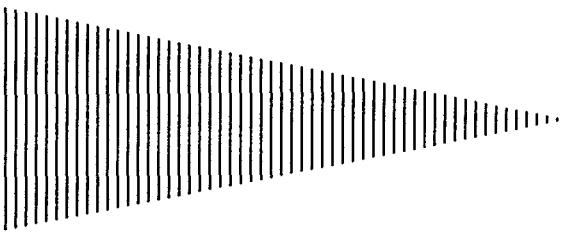

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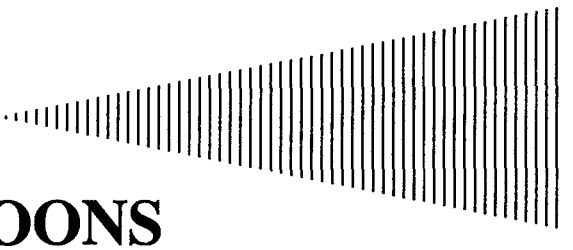

THE SATURN AND SATURN'S MOONS

Among all the objects orbiting round the Sun, the one whose appearance is awesome and spectacular is the Planet Saturn. In terms of size, Saturn is the largest among all other planets, except Jupiter. It is the outer most of the planets visible from Earth with the unaided eye. In term of size Saturn may be next to Jupiter, but its beautiful and incredible rings system makes it outstanding and puts it in a class by itself. "Saturn" is the name of Jupiter's father in Greek mythology and Romans have named the planet the same name "Saturn".

Saturn orbits the Sun nearly 10 times further away from the Earth. This means it receives only one hundredth as much heat and light as the Earth. Consequently, it is frigid world, with cloud and wind systems similar to those of Jupiter.

Saturn's composition is very much like that of Jupiter. There is probably a solid core composed of iron and silicates that measures less than 9300 miles in diameter and is covered by a layer of water kept in solid ice form by the pressure of successive higher layers of metallic hydrogen and liquid molecular hydrogen. Like Jupiter it is almost entirely made up of hydrogen and helium and pale zones of ammonia clouds.

Winds near the equator blow at 1800 km. per hour, four times faster than Jupiter's worst winds, and 20 times as bad as a severe gale of Earth. The markings are much fainter than Jupiter. Occasionally white spots can be seen but these are rare. Saturn may have had the same star like ancestry as Jupiter. Saturn's atmosphere is smoother, hazier and less choppy than Jupiter's white and Great Red spot. The fact that Saturn's clouds tops are smoother than Jupiter's may be due to its weaker gravity and lower temperatures.

Saturn takes 29.5 years to orbit the Sun. It spins on its own axis in just 10 hours. This fast spin makes the planet bulge at its equator. Saturn is 95 times more massive

than the Earth. Saturn's rings system is certainly the planet's outstanding feature. The rings are beautiful and do not touch the planet, it is a marvelous thing. Out of those, three main rings are visible through large telescopes. Voyager photographs show that Saturn really has a number of ringlets that blend together when viewed from as far away as Earth. The rings are tilted at angle of 29° to the orbit. This means that they slowly change their appearance, when viewed from the Earth. For a year or so we can see the rings as wide as they can be in a telescope, then they slowly seem to found up until 15 years. Later we view them from the side, and then they almost vanish.

When Galileo was studying the planet, he was really baffled and surprised to see the rings appearance and disappearance and did not know what the objects are. In 1655 after Gelileo, the Dutch astronomer Christia Huygens (1625 to 1695) solved the riddle. Using more powerful telescope he figured out that the mysterious objects were rings around Saturn and the reason for their "disappearance" in 1612. He also went out to calculate that the rings would be oriented in this way on a 150 month cycle and that at the opposing ends of the same cycle almost the entire ring would be visible from Earth. It has since been determined that the cycle actually alternates between the periods of 189 and 165 months. Huygens also discovered Saturn's largest moon Titan.

The particles of rings are probably made of water ice or bits of rock covered in ice. Mostly they are about a meter in size, but the range runs from a few centimeters to tens of meter. There are few larger objects in the rings, stones and boulders upto a few hundred meters across. They all orbit the planet as if they were unrelated satellites. The Voyager spacecraft focused on Saturn's rings in 1980 and found that there are countless very thin ringlets. The gaps between the rings, which caused by Saturn's many moons, have caused the rings to split through the action of gravity.

The gaps between the rings are caused by Saturn's many moons which cause the rings to split through the action of gravity. "The rings are not solid, in fact bright stars shine right through the rings, without their light really being deemed at all. Although the rings are 400,000 km. across, they are only a few tens of meter thick. The inner parts orbit Saturn faster than the outer parts. The rings are mainly made of billions of tiny particles and each speck is orbiting Saturn like a microscopic moonlet."

Note: The sentence/para in inverted comas indicate that the said sentence/para is/are taken from *The Young Oxford Book "Astronomy"* by Simon and Jacqueline Mitton, London, UK.

" SATURN'S FACT FILE:

Mass	95 Earth, 5.68×10^{26} kg.
Diameter at the equator	9.46 Earth, 120,420 km.
Rotation Period	10.54 hours.
Period of Orbit (year)	29.46 years.
Distance from the Sun (average)	9.54 astronomical units 778 million km. "

● SATURN'S MOONS

Saturn's rings have made it very beautiful and spectacular. Its more than 20 moons have a complex system, all these have made it a distinct position among all the planets' moons. Saturn's moons range in size from huge Titan, once thought to be the Solar System's largest moon, to the family of the tiny moons that were discovered in photographs taken by the Voyager space craft in 1980. At the same time, it was found that there are countless very thin ringlets and that the rings have made Saturn very beautiful and spectacular.

Saturn was known to have 17 moons and six (17 + 6 = 23) additional lagrangian co-orbital satellites. A co-orbital is one group of moons that share a single orbital path, while lagrangian satellites are small co-orbitals that exists in the orbit of larger moon's 60 degrees ahead or 60 degrees behind it in the orbital path. And now the scientists and astronomers have found 12 new moons around the Saturn.

Among all the Saturn's moon, Titan is the most important in many ways. It is larger than the planets Mercury and Pluto. It was discovered by the Dutch Astronomer Christian Huygens (1629 – 1695) in 1655. At that time it was supposed to be the largest moon in the Solar System but afterwards it was found that Jupiter's moon Ganymede is the largest. But though it is not the largest it has the second rank in size and is the most spectacular one.

Titan is the only known moon with a fully developed atmosphere, that consists of more than simply trace gases. It has, in fact a denser atmosphere cloud cover than Earth or Mars. Titan's atmosphere, is extremely rich nitrogen. The same element that makes up the greatest part of the Earth's atmosphere. Which mainly consists of nitrogen with some methane. No other moon in our Solar System has an atmosphere. Other major components of Titan's atmosphere are, hydrocarbon gasses such as acetylene, ethane and propens with methane being the most common of the hydrocarbons. Titan could be some what like the Earth, with rain, snow, oceans and

rivers. The difference would be that these are all made of methane, rather than water. While these gases are also to be found in Saturn's own atmosphere.

Titan's mantle is largely composed of water ice that gives way to a rocky core perhaps 600 miles beneath the surface. The absence of magnetic field indicates that Titan has no significant amount of ferrous metallic minerals in its core.

The presence of nitrogen, a hydrocarbon atmosphere and water indicate that Titan's surface is very much like that of the Earth, four billion years ago, before life evolved on the Earth. It has been suggested that this similarity to the prebiotic "Soup" that covered the Earth in those **by-gone** days could presage a similar chain of events on Titan.

The following are the names of the Saturn's other moons:

" 1. Mimas
2. Mimas Co-orbital
3. Euceladus
4. Tethys
5. Telesto
6. Calypso
7. Dione
8. Dione Co-orbital 1
9. Dione Co-orbital 2
10. 1980S6
11. Rhea
12. Hyperion
13. Pholebe
14. lapetus
15. Janas (1980 S 1)
16. Epimetheus (1980 S 3)
17. Pancbra (1980 S 26)
18. Prometheus (1980 S 27)
19. Altas (1980 S 28)
20. Titan, the most important that we have studied. "

NEW DISCOVERY

It appeared in Marathi paper "Loksatta" on Thursday, the 12th July, 2001, the news is "Twelve new Moons have been found around the planet Saturn", the news, I am giving hereunder is the translated into English.

The Coat D Azoor Observatory at Neece from South France, has found these Moons around the planet Saturn. The scientists from France, Canada and U.S.A. have worked together under the guidance of Dr. Bret Gladman. These Moons have diameter from 6 km. to 32 km.

Up to this time, Jupiter, which has 28 moons, was supposed to be the number one, in having a great number of moons. But, now this credit goes to Saturn. It has become the exclusive planet for having maximum number of moons.

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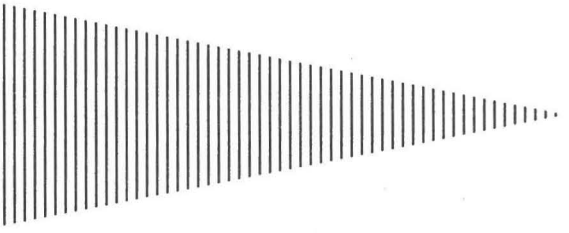

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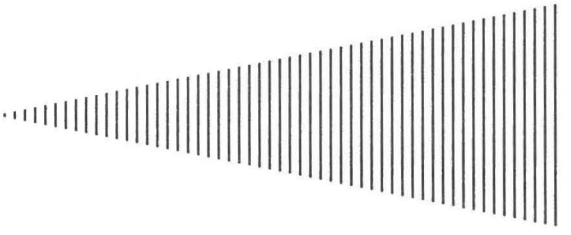

THE URANUS AND ITS MOONS

Uranus was identified in 1781 by the German born English astronomer William Hershel (1738 – 1822) while he was working at Bath in England. Hershel's discovery made him world famous. At first astronomers could not agree on a name for planet but they eventually chose Uranus. In classical mythology Uranus is the grand father of Jupiter.

Uranus is a gaseous planet like Jupiter, Saturn and Neptune, with a distinct blue-green (colour) appearance probably due to a concentration of methane in its upper atmosphere. In terms of size it is smaller than Jupiter and Saturn while it is very close to the size of Neptune. Its solid core is almost composed of metals and silicate rock with a diameter of roughly 270,000 miles. Its core in turn covered by an icy mantle of methane ammonia and water ice 6000 miles deep.

As with the other gaseous planets the predominant elements in the Uranian atmosphere are hydrogen and helium. Other atmospheric constituents include methane, acetylene and other hydrocarbons.

The clouds that form in this atmosphere are moved by prevailing winds that blow in the same direction as the planet rotates, just as they do on Jupiter, Saturn and Earth. The planet's lowest atmospheric temperature – 366 degree fahrenheit is recorded at boundary between the troposphere and stratosphere, surprisingly, both the poles show similar temperatures, whether or not they are sunlit. The coldest latitudes seen to be those between 15 to 40 degrees in the upper atmosphere temperatures increase to – 190 degree fahrenheit, while in the planets interior it is extremely hot – as are the interiors of Jupiter and Saturn.

The Uranus rotates retrograde on its axis in 17 hours and 14 minutes and its orbital period that is Uranian year is 84 Earth years. "The spin axis of Uranus is titled over by more than a right angle, which means its north pole actually points below the plane of the planet's orbit. This is unique in our Solar System. As Uranus takes 84 years to orbit the Sun, its seasons must be very strange. For about 20 years its north pole points out more or less towards the Sun, while the south pole is in the permanent darkness".

The magnetic field of Uranus has roughly the same intensity as the Earth's, but whereas the Earth's magnetic field is generated by a molten metallic core, the one surrounding Uranus seems to be generated by the electrically conductive Super – pressurized ocean of ammonia and water that exist beneath the atmosphere.

Uranus like Jupiter and Saturn has a System of rings of which the first were discovered by Earth based observers in 1977. This ring system is much more complex than that of Jupiter but less than Saturn's. Spectacular System. The ring system around Uranus is relatively young and probably did not form at the time as the planet.

"When Uranus passed in front of a faint star, astronomers observed, the twinkling of the starlight. What they found was that the star winked on and off several times before and after being blotted out by Uranus. Nobody had predicted this effect, which was caused by at least nine faint rings that orbit Uranus".

The widest ring known before Voyager 2 was the outer most ring, Epsilon – an irregular ring measuring 14 to 60 miles across. In 1986 Voyager's camera helped to identify a new innermost ring designated 1986 U2R that is 1550 miles wide.

The narrowest complete rings are less than a mile wide, while faint possibly incomplete rings have been identified which are only 160 feet across. The rings are composed of large blocks of ice with small dust, particles scattered throughout the system.

● THE URANIAN MOONS

Prior to the observations by Voyager 2, Uranus was known to have only five moons. But photographs returned by the space-craft increased the number of known moons to 15, with all ten of the newly discovered moons located within the orbital paths of the original five. One of the new moons 1985 U1 was discovered by Voyager's cameras in late 1985 and the rest were discovered in the photos taken during January, 1986. Voyager flyby of the Uranian system with the exception of

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1985 U1 and 1986 U1 the largest and smallest of the Voyager moons all of the newly discovered members of the groups are very uniform in size with diameters ranging between 31 to 37 miles.

Miranda

There are five large moons and 10 tiny moonlets around the Uranus. The most amazing of these is Miranda, which is nearly 500 km across. The surface has a bewildering variety of valleys, grooves, steep cliff. The moon seems to be made of three or four lumps of rock that have fused together. It may be the remains of a moon that once crashed with an asteroid and has now managed to pull itself back together again through the force of gravity.

All the Uranian Moons names are:

" 1. 1985 U 1
2. 1986 U 1
3. 1986 U 2
4. 1986 U 3
5. 1986 U 4
6. 1986 U 5
7. 1986 U 6
8. 1986 U 7
9. 1986 U 8
10. 1986 U 9
11. Miranda
12. Ariel
13. Umbriel
14. Titania
15. Oberon "

" URANUS FACT FILE

Mass	14.5 Earth, 8.7×10^{25}kg.
Diameter at the equator	4.0 Earth, 51,300 km.
Rotation period	17 hours 14 minutes
Period of orbit (year)	84 years
Distance from Sun (average)	19.2 astronomical units 2.86 billion km. "

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CHAPTER 14

THE NEPTUNE AND ITS MOONS

Neptune was found in 1846 as a result of careful search after the discovery of Uranus. For many years astronomers had been, puzzled because Uranus kept drifting off course. They used Newton's law of gravity to work out where Uranus should be, but kept finding that its actual position did not match the predicted one. They knew that this would happen if the gravity of an undiscovered planet was tugging Uranus.

Two mathematicians set to work on computing where the unseen planet would have to be. In 1845, in Cambridge, England, John Couch Adams (1819 – 1892) teamed up with James Challis (1803 – 1862) at the University observatory. Although Challis actually recorded the new planet, he did not realize, he had found it. At almost the same time French astronomer, Urbain Leverrier (1811 – 1877) was trying to persuade the Paris Observatory in France to search. He also wrote to an observatory in Berlin, Germany. On the night of receiving that letter (23rd September 1846), Johan Galle located the suspected planet. It was named Neptune after the Roman God of the Sea. "Neptune is 30 times further the Sun, than the Earth is. The sunlight that reaches Neptune is feeble and it's temperature is – 213 C. However this is little warmer than the Uranus, which is closer to the Sun. The explanation is that, Neptune has internal heat and it actually gives off nearly three times as much heat as it gains from the Sun".

This blue-green giant is a near twin of Uranus in terms of the size and the chemical composition of its atmosphere. Unlike Uranus but like Jupiter, however Neptune radiates more heat than it absorbs and it also has a greater density and

mass than the slightly larger Uranus. Like Jupiter and Uranus, Neptune may eventually be shown to have a faint ring system, as has been suggested by occultation data.

Physically, Neptune is characterized by a dark band at its equator and lighter coloured temperate zones in its Northern and Southern hemisphere. The dark band is perhaps evidence of the shades of planetary rings or perhaps simply the absence in the equatorial region of the methane Crystal haze and/or water ice. Crystal haze that drifts above the cloud tops in Neptune's colder temperate zones.

Prior to the American Voyager 2 space-craft encounter with Neptune in 1989, the planet was known to possess the moons. Prior to the Voyager 2'S encounter with Uranus in 1986, only five Uranian moons were known as Voyager's observations tripled that number. This fact alone will lead to suspect that there may be more Neptunian moons.

The two Neptunian moons known prior to 1986 are among the most peculiar in the Solar System. Triton discovered less than a month after Neptune, is a huge object with the only retrograde orbit known in the Solar System, while Nereid discovered more than a century after Triton, has the most elliptical orbit of any known moon in the Solar System.

" NEPTUNE FACT FILE

Mass	17.2 Earth, 10×10^{26} kg
Diameter at equator	3.9 Earth, 49,500 km.
Rotation Period	17 hours 52 minutes
Period of orbit (year)	165 years
Distance from the Sun (average)	30 astronomical units, 1.5 billion km. "

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CHAPTER 15

THE PLUTO AND CHARON

● PLUTO

1. During the mid-to-late 19th Century, astronomer studying the revolutions of Uranus and Neptune detected slight anomalies or small deviations that could be explained by the gravitational effect of another body farther out the Solar System. And around the turn of the century, Percival Lowell (1855 – 1916) took up a systematic search of the heavens, looking for what he called "Planet X". After his death, the search was continued by others. In 1919, Pluto was actually photographed, but not noticed because, it was much fainter than it was predicted to be. Then the organized search for Planet 'X' was largely abandoned.

In the meantime, William Pickering for the first time predicted that the perihelion of the "Planet X"s orbit might actually bring it briefly closer to the Sun than Neptune. It was a radical idea that turn out to be accurate for Pluto.

2. "Then in 1930, a young astronomer at the Lowell Observatory, Arizona, Clyda Tombaugh announced the discovery of a very faint planet, as a result of a very detailed search and that was the Pluto. The diameter of Pluto is 2324 km. and it has an elongated orbit. The closest Pluto gets to the Sun is 4425 million km. and the greatest distance it gets from the Sun is 7375 million km. In 1979, Pluto actually crossed over Neptune's orbit and it passed beyond Neptune again in 1999", during this period it was much closer in the Solar System than its regular orbit. Pluto's name was given after the Roman God of Dead and also because the first two letters were Percival Lowell's initials.

Note: The sentence/para in inverted comas indicate that the said sentence/para is/are taken from *The Young Oxford Book "Astronomy"* by Simon and Jacqueline Mitton, London, UK.

3. Pluto was smaller than originally suspected, and it is found to be the smallest of the nine planets and smaller than the seven of the planetary moons. As estimated, the Pluto's size is very much smaller than to exert the gravitational force on Neptune's orbit, that was originally predicted. This would means that Pluto is not "Planet X".

Pluto's behaviour, that sets it apart from other planets, is its steep inclination to the ecliptic plane. The orbits of all the planets are within two and one half degrees, this same plane, except Mercury (7 degrees) and Pluto itself, which is inclined at acute 17 degrees making it very unusual among other planets.

4. According to the physical nature of Pluto, it holds that at one time it was actually one of the moons of Neptune. However, it is further theorized that it was somehow thrown out of Neptunian orbit by some calamitous interaction with Neptune's moon Triton.

Very little is known about Pluto's physical character than all other planets. It is extremely cold with noon time summer temperatures rarely creeping above –350 degrees Fahrenheit. Its rocky surface is also known to contain Methane probably in the form of ice or frost, water ice may also be present and Pluto's mass suggests a rocky core. Pluto has a very thin atmosphere which probably freezes into the ground. It is completely different from its neighbours, the gas giants.

5. The Kuiper Belt — "There is a ring of small planetary objects at far edge of the Solar System, beyond Neptune, known collectively as Kuiper Belt. Several objects that are 100 – 200 km. in size have been found and Pluto could be orbiting within this belt. Charon could have been captured by Pluto from this belt and Triton by Neptune. The planetsimals which are also called the mini-planet are the remnants of the materials from which the larger planets formed in the early Solar System".

● CHARON

The discovery of the Plutonian Moon, Charon came about indirectly in 1978. Photographs taken in 1978, showed images of Pluto shaped like an egg that means they were not spherical. This seemed to indicate that there could be a moon orbiting close to Pluto. Further observations led the scientist to the conclusion, that the elongation he had observed was due to the presence of a satellite very close to Pluto. And further calculations indicated that this newly discovered body was as close as 10,563 miles from Pluto, they are like a pair of dwarf planets. Very little is known about its physical properties, although, it is possible that Methane ice exists on

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Charon as it does on Pluto Charon revolves around itself every 153 hours, exactly matching the Pluto's rotational period, meaning that the same hemisphere of Charon faces the same hemisphere of Pluto at all times.

" CHARON FACT FILE

Mass	0.0003 Earth, 1.8×10^{21} kg.
Diameter	1212 km.
Revolution around itself	153 hours.

PLUTO FACT FILE

Mass	0.0022 Earth, 1.3×10^{22} kg.
Diameter	2324 km.
Distance from the Sun	between 29.65 (Nearest) and 49.28 (farthest) astronomical units, on a very elliptical orbit.
Rotational Period	6 days, 9 hrs., 18 min., 6.3 Earth days, 153 hours
Orbital Period (year)	248 Earth years. "

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CHAPTER 16

THE CONSTELLATIONS AND THE ZODIAC

A constellation is a pattern of stars. Ancient astronomers found that the constellations were easier to recognize than individual stars.

Constellations are patterns or groups of stars that seem to form a particular shape of animal, person or objects. These stars appear to form these shapes, and we feel them closer to each other but in reality the stars in constellations are very distant from each other. There are 88 recognised constellations in the heaven, but out of them 12 are the most important ones. The names of these 12 particular constellations are probably better known than most of the others.

They are called Zodiac. Zodiac means belt of living things because almost all of these constellations are named after animals or mythical beings, Libra is the only exception that does not belong to that category.

All these twelve constellations are well known to most people because they belong to the so-called Zodiac. Zodiac is a band of constellations circling the sky. The Zodiac gained its importance in astronomy because, the yearly path of the Sun through the Stars known as the "ecliptic" lies within this band and the paths of moon and the planets except Pluto are always within it.

The paths of the planets around the Sun and the orbit of the Moon around the Earth, all lie very nearly in the same plane.

During the day, we cannot see the stars but they are still there. If you could see the day time stars, you would be able to see directly the constellation in which the Sun is located. This is actually possible during the few minutes of a total solar eclipse.

"For the same reason the constellations visible at night gradually change over a course of year, the Sun appears to make one complete tour round the sky during a year and we pass twelve important constellations during the year. The modern constellations of the Zodiac are not of equal size, so, the Sun spends different lengths of time in each. (12 names are Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius, Pisces, ... Zodiac Circle. As our planet travels through space we get a different view of the stars, and we feel as if constellations have changed the shapes".

The ancient philosophers and their predecessors lived around the Mediterranean, the region we call the Middle East, from there they could never see the parts of the Southern sky. Not until explorers started to travel in the South. European astronomers give names to the constellations in this part of the sky. So they have all been added since about 1600.

Astronomy and Astrology – In contrast to the true Astronomical situation, astrologers choose to divide the zodiac band into 12 equal parts, called "houses", which are given the same names as the 12 traditional zodiac constellations. The astrological houses no longer correspond with the positions of the real constellations. Your astrological 'sign' is determined by which house the Sun lies in at the date of your birth. The Sun is generally not in the real constellations of that name on your birthday.

Astrology probably arose, when people first realized that the Sun and the Moon have a direct effect on tides, the weather, and the seasons. From this it must have seemed to believe that planets might also have small effects. Today most astronomers do not take Astrology seriously. Centuries ago many useful astronomical observations were made because of the belief that could affect human affair. Today most astronomers do not take astrology seriously. Centuries ago, however many useful astronomical observations were made because of the belief that the stars could affect human affairs. Today there is no connection between astronomy and astrology.

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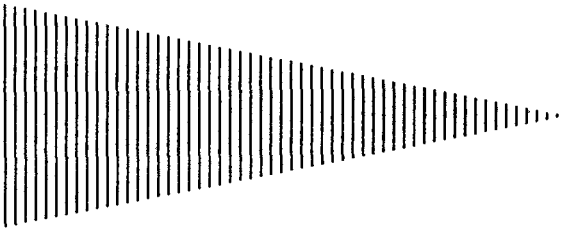
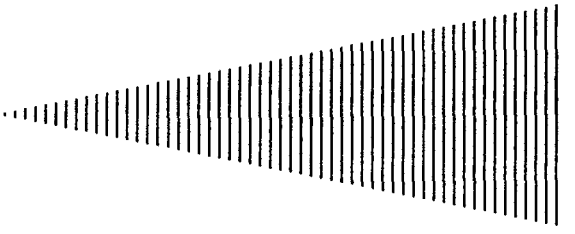


CHAPTER 17



THE ASTEROIDS AND METEORS

In the 342 million miles interval between the orbits of Mars and Jupiter is a vast collection of a small planet like objects called asteroids. Literally they are fragments of rock that may have their origin in the cataclysmic destruction of one or several terrestrial planets or they may be debris left over from the origin of the Solar System itself. There are only six khown asteroids with diameters greater than 100 miles and ceres the largest asteroid is 582 miles in diameter. It is quite small to be qualified as a real planet. It proved to be the first of many similar minor planets, or asteroids, found by later astronomers, most of them cruising around the Sun between the orbits of Mars and Jupiter, and this orbital area of these two planets is called the "Asteroid Belt".

"Many thousands of minor planets or asteroids are now known. Almost all of them take three to six years to orbit the Sun. They are swarming between Mars and Jupiter, in the Asteriod Belt Zone. Another belt is discovered beyond Neptune in 1993 which is called the Kuiper Belt.

The biggest asteroids are 20-100 km. across. Ceres and a handful of other asteroids are quite exceptional because they are as big as some planetary Moons. Most known asteroids are smaller than 20 km. Astronomers think that millions of boulders, stones and grains of sand are cruising through the asteroid belt".

Asteroid can get trapped if they stray too close to Jupiter. There are two families of asteroids that march round the Solar System in front of and behind Jupiter, they

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are named as the Trojans. Occasionally, one of them tumbles right into Jupiter's gravitational pull and becomes a tiny satellite of Jupiter.

The big planets in the Solar System tug them this way and that. Their orbits can suddenly go off track and then an asteroid can be hurled towards the Sun. "Astronomers have already found more than 1000 asteroids with orbits that cross the Earth's annual path round the Sun. The tiniest satellites within the Solar System could be asteroids that were trapped by their parent planets".

Asteroids are so small that they cannot be counted but it is now possible to detect smaller and smaller asteroids, the number of known asteroids is likely to increase indefinitely. The total number of asteroids is estimated at 30,000. Asteroids vary widely in their shapes and characters. They are also varied in their colour and composition.

By studying asteroids, astronomers hope to learn much about the material from which the planets are formed. In the recent past (astronomically speaking) comets and asteroids have slammed into the Earth. The Meteor Crater in Arizona, U.S.A. and also a Lonar in India are only about 50,000 years old. The Tungusaka event in Siberia occurred in 1908. This seems to have been an explosion of an asteroid or worn out comet in the atmosphere. Impacts like these are very dangerous to the Earth, several known asteroids are likely to pass within 1 million km. of the Earth in the near future. Astronomers are making searches for near-Earth objects of this kind so that they can detect in advance any that might come dangerously close to the Earth. It might be possible to send a nuclear bomb to, nudge to one side any really dangerous asteroid.

"Of all the objects that astronomers study, only asteroids, comet and meteorites can affect the Earth in a way that could cause disaster. However, the chance of such a thing happening to us is very small indeed. Many of the world's people are much more at risk from earthquakes and volcanoes, disease, and famine". So our scientists and astronomers are there to take care of us, and we have nothing to worry about.

● METEORITES, METEOROIDS, METEORS

All the three are stones that fall from the sky. Mostly they are left from the formation of the Solar System. There is a surprising amount of cosmic debris between the planets, much of it is left behind when the planets formed and some are recent, such as the dusty trail left by comets. To describe this material, astronomers use three similar words meteoroid, meteor and meteorites.

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1. "A meteoroid is a piece of rock or dust out in space. The Earth is constantly bombarded by objects ranging in size from specks of dust upto rocks weighing several kilograms. These enter the atmosphere at speeds of 60,000 km. per hour, or more. Friction with the air heats the particles until they grow red-hot. A meteor is the visible trail in the sky which is left by an object that gets burned up as it enters the atmosphere. That means the meteor become so hot from rushing through the Earth's atmosphere, that they vaporize. Nothing is left of them, and because they get burned, a sparkling light is seen for a moment and we feel as if a star is falling. So these trails are also called shooting stars. A meteoroid that reaches the ground is called a meteorite and are often named after the place where they fell".

2. "Much of the dust, debris and rock, all this material is orbiting the Solar System in streams, where comets have also left a trail of rubbish as they hurtle through the Solar System. When the Earth crashes through one of these streams, a meteor shower may be seen, streaks of light caused as dust specks burn up in the atmosphere, appear to radiate from a single point in the sky. Meteor showers are predictable, because the Earth tends to cut through a stream on more or less the same date each year".

3. "Rocks that survive the fiery journey through the atmosphere are not all that common. All those hit Earth's surface are almost very small dust grains but only 20 or so meteorites are found each year from new falls. Radio-activity in meteorites shows they were formed 4-6 billion years ago, as a part of the Solar System".

There is no record of any human death from a meteorite, although there have been close escapes. Large meteorites have left substantial craters. The one in Arizona is the best preserved, because the dry desert climate has prevented erosion and weathering since its formation about 50,000 year ago.

According to astronomers a few meteorites have come from the Moon and even Mars. So there are variety in the composition of meteorites and astronomers are very eager to study them.

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CHAPTER 18

THE COMETS

"Comets are relics from the birth of our Solar System. For billions of years they have spent their lives in the deep freeze of remote space. They are essentially 'snowballs' of carbon dioxide, methane or water ice, ammonia. Gritty dust, heavy stones and lumps of metal are encased in this icy mixture". All of these materials were present in the interstellar cloud from which the Sun and Planets formed. Comets are made of remnants of these materials from the stuff that are left behind. This snowball usually contains a solid core, which is the permanent part of the comet and is known as its nucleus. The cometary nucleus is usually quite small.

Comets have extremely elliptical orbits and which exhibit spectacular tails when heated by the Sun. They travel around the Sun in fixed elliptical orbits that have perihelions less than that of the inner terrestrial planets and aphelions that can be as great or greater than outermost planets. The period of time that it takes for a comet to make a complete revolution around the Sun may range from a few years to many centuries. Much further out about a light year from the Sun we would come to 'the Oort Cloud' of Comets. We can be sure there are countless small icy objects to be found, but no major planet. This 'Oort Cloud' is supposed to be house of comets, all comets come from this 'Oort Cloud'.

"When a comet journeys to the Sun, changes take place. The gravity of the Jupiter pulls it, inside the Solar orbit. The Sun's rays first warm the icy snowball directly. By the time the comet is inside the orbit of Jupiter, Solar heating starts to boil off the ice, and gas builds up around the speeding comet. A large gassy cloud

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named the Coma surrounds the comet. As the ice melts a dusty crust builds up on the comet's surface. This is usually a very uneven layer, so the gas still being released inside starts to burst out in jets, almost as if the comet had miniature volcanoes." Fountains of material spewing from the comet can even change its orbit slightly.

As a comet races ahead along its Orbit, the dust and gas get stranded forming a comet tail. The radiation leaving the Sun pushes the tail away from the Sun. Although the nucleus of a comet head (the icy snowball) may be only a few kilometers in diameter, the tail can become upto millions kilometers long. When a comet starts its return journey, after it has passed round the Sun, it starts cooling down, as it moves further away. Meanwhile, along the orbits of the comet, larger lumps of dust, stones, and metal flake away. The production of gas, slows down, the coma shrinks and disappears the jets stop and the tail dwindles away (Vanishes).

When a comet returns after its tour round the Sun, then also there are changes in it. Upto this time, comet losses material through heating and the creation of the tail. After burning up every thing only the barely visible nucleus, the core of the comet reaches its house – "The Oort Cloud" and stays there. Again it starts developing into icy snow balls, it takes certain time for an every comets to form **fullflaged** icy snow ball. This time is fixed. Sometimes the comets are so small that their development's time is ¾ years only, while some are so big that they take even more than century for their development. These comets are called periodical and the scientists are sure about the time for their return appearance. These comets can have life upto millions of years.

Every time it appears, its power is lower down and after certain period, after having many rounds the comet gets completely burnt up and its life comes to an end. Halley's comet is also a periodical it returns after every 76 years. Some comets are so small, that they get completely burnt up at their first round only and vanishes.

At the time of its each tour round the Sun, the periodical comet looses its material over a period (some times about millions of years also in case of very big comet) and the comet dies after having burnt everything. But the new comets are also formed, this process is going on continuously.

There are some remarkable comets other than Halley's comets –

"1. Comet Arend-Roland (1957)
2. Comet Biela (1772)
3. The Day Light Comet (1910)
4. Comet Donati (1858)

5. Comet Encke (1786)
6. Comet Ikeya-Seki (1965)
7. Comet Kohoutak (1973)"

So, dearones, here ends our story of The Solar System. How did you like it?

And now, in second part, we are going to learn about our Earth. I know you must be knowing something about our Home Planet the Earth. Its but natural. Even then, I am trying to tell you so many geological aspects alongwith some natural aspects about the Earth that perhaps you may not be knowing. Till then, rest yourself, have a change and enjoy yourself.

B.....ye !

Shamaaji

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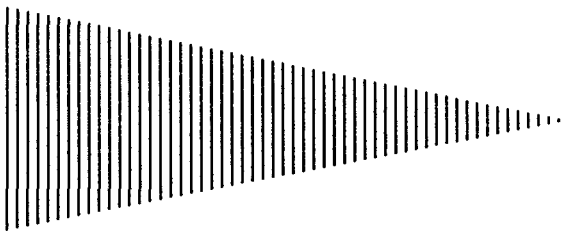
PART - II

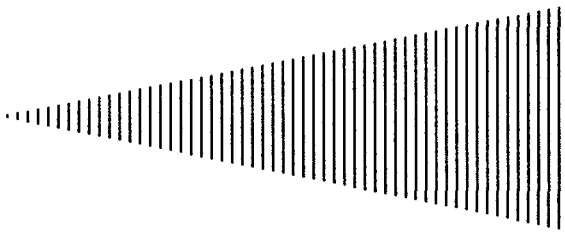
THE EARTH
(GEOLOGICAL AND NATURAL)

CONTENTS

PART II



CHAPTER 1



THE EARTH

INTRODUCTION

Hellow!

Friends, Shamaaji is calling you, are you fresh now ? Come on then, we will start our story of the Earth. That way, we have studied the planet Earth as a part or member of the Solar System, and now we are going to study it as the Earth itself.

First of all, I must say that all of us know very well, how beautiful, cheerful, interesting and at the same time marvellous and mysterious our Earth is ! It is our home planet, we are all living on it (except austranauts who move in space by space ships). Everybody is doing something, this way or that way on the Earth only. Even a small child is playing or crying, whatever it does, does on the Earth. The Earth is our mother, it gives us birth and produces and provides us whatever we need for life.

The Earth's surface is covered with the continents and the Oceans. Three fourth part of the Earth is covered with oceans (water) and only about one fourth part is covered by continents (lands) This land has so many varieties. The high lands the mountain ranges – many of which are covered with ice, the great valleys, the big rivers, the lakes, the plains, the plateau, the deserts, the big and tall forests and what not ?

Mainly there are three types of regions. The north most and south most regions, are very cool and at both the extremes they are icy cool. Then there are temperate regions, and near the equator there are tropical hot regions. Again there are great varieties of nature and climate among these regions. It is full of such a great variety of nature that we can't even imagine it. People living on the same planet have totally

different life according to their regional lands and climates. Some times there is abundant farming, vegetation, fruits, a great variety of combinations, while in icy cool regions, people have a very hard life many times they have to rely on sea food only. There is a great difference in wearing the clothes according to climate. People have to lead totally different life as per their own lands.

Friends, do you know, how our Earth looks when seen from above, from the space? The astronauts say that the Earth looks like a huge blue ball shining in the black sky. We have already seen that the sky in the space is dark unless there is a shining star or a planet that receives stars rays. The surface of the Earth is often covered with enormous patches of swirling white clouds and again because of the oceans, our planet Earth seems to be blue.

We have seen that the Earth is the third planet in our Solar System and has the distance of 93 million miles from the Sun. We are so lucky to have our Earth's distance from the Sun, as that it makes our Earth eligible to have life on it. It is neither too hot nor too cold, it is moderate one, which makes so many species of life to grow and develop. No other planet has such peculiar condition. And that is why our Earth **is a distinct and special planet.** All the planets receives energy from the Sun, but Earth is the only planet to support living things (beings) as it is warm and has an atmosphere.

Now, we will see various varieties inside the Earth and on the Earth. Mostly we are going to see the geological and natural aspects of the Earth. Be ready now.

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CHAPTER 2

GEOLOGICAL ASPECTS

● STRUCTURE OF THE EARTH

Now let us see important geological aspects of the Earth. We have seen that scientists believe that the Earth was formed 4.6 billion years ago, from a spinning cloud and dust which shrank and then formed a ball of liquid or molten rock. We have also seen that when it was cooled, the Earth's surface formed into a solid crust. Under this surface or say crust the temperature is so high, that almost most of the parts of the Earth are still liquid.

Inside the Earth, there are four layers:

(1)The Crust, (2) The Mantle, (3) The Outer Core, (4) The Inner Core

The Crust

The Crust is the surface layer of the Earth. It is thicker under the continents, usually about 32 kilometres thick, and where there are high mountain ranges, it can be upto 40 kilometres thick, this crust is mostly made of a rock called granite. The crust is very thin under the oceans, and is made of a rock, called basalt, and is about eight kilometre thick.

Underneath the crust, there are three layers of hot rocks and metals viz. – the mantle, the outer core and inner core.

The Mantle

The mantle is the biggest part of the Earth's bulk. It is 2,900 kilometres thick and is the layer of rocks, some of which are molten. It is underneath the crust and it

surrounds the upper part of inner and outer cores. Temperature here is so high that it is hot enough to melt iron and it is made of rocks and molten rocks i.e. in liquid form.

The Outer Core

Above the inner core and below the mantle, in-between the two lies outer core outer core is made of molten rocks. It is the only liquid part of the Earth's structure (except oceans).

The Inner Core

Inner core is the centre of the Earth's bulk. It is believed that it is ball shaped and made of iron and nickel. Temperature here is very very high beyond imagination, even then the metals here are solid. How come ? It's wonderful ! Friends, scientists believe that, it is because of the enormous pressure caused by all other layers pressing down on top of them.

● MOVEMENTS INSIDE THE EARTH

The Folds, the Cracks and the Faults

Inside the Earth, molten rocks, liquid, gasses etc. are so hot, beyond our imagination and everything is boiling and moving from here and there, though very slowly, it is never still and so is called the restless Earth. Movements of this molten material in the outer core is thought to produce the Earth's magnetic fields.

Friends, do you know that Earth's crust is not a huge single piece but it is cracked at several parts forming large sections called plates or rather tectonic plates. The Earth's crust is made up of pieces of these plates. They float on the top of a layer of molten rock in the mantle. There are seven main plates and several smaller ones. The magnetic force within the Earth make the plates move, though slowly.

Sometimes there is a great compressional stress, the rocks are pushed in by all the sides, and are crumpled, twisted and wrenched into all sorts of shapes. This is the folding of rocks.

Thus Rocks bend and twist under the great forces that move the continents, as the crystal plates are always floating on the layer of mantle, they force to move the continents as they are the uplands of the crust. Sometimes the rocks do not fold, but they break, that means there are cracks instead of folds. When this happens, it is called fault. These cracks on the Earth's crust are known as **faults**.

As the plates move around the Globe, they collide, overlap and slide past each other. They travel too slowly at the speed about 6 inc. (15 cm) in a year. But over

a millions of years the result of these movements is so vast, that we can't even imagine it. Huge mountain ranges, spectacular rift valleys, and deep trenches in the ocean bed, have been formed, where two plates meet. Earthquakes, volcanoes, geysers and hot mud pools are also caused by the plates movements. The region where they are found, closely follow the joint between the plates.

Geologists believe that about two (2) million years ago, all the land on Earth was joined together and there was the single massive continent, which they call Pangea. Then in course of time, some parts of mass of land was drifted away from the original, then some parts were gradually separated from each other. It was by continental drift that the continents have come to their present position on the Earth's surface. And it will be by the same process the continents will continue to move apart.

The continents are the uplands of the Earth's crust, they comprise togetherly less than one third part of the Earth's total surface. About 70% of the total surface area is covered by water — the four major oceans and a number of small bodies like seas, lakes, rivers etc.

● THE CONTINENTS

There are seven (7) continents altogether

"(1) Asia — 16,838,365 sq. miles, 43,608, 000 sq. km.
(2) Africa — 11,712,434 sq. miles, 30,335,000 sq. km.
(3) North America — 9,785,000 sq. miles, 25,349,000 sq. km.
(4) South America — 6,886,000 sq. miles, 17,835,000 sq. km.
(5) Antarctica — 5,400,000 sq./miles, 14,000,000 sq. km.
It is always covered under ice and surrounded by cold seas.
Antarctica covers 93% of all the worlds' ice and has world's coldest temperature that is – 128.6 F(-89.2 C)
(6) Europe — 4,053,309 Sq. miles, 10,498,000 sq. km.
(7) Australia (Oceania) — 3,445,197 sq. miles 8,923,000 sq. km."

● THE OCEANS

"(1) Pacific Ocean 63,838,000 sq. miles, 165,384,000 sq. km. The biggest Ocean on the Earth. While mapping the Earth, mostly Pacific is divided into two parts (i) Western side of North and South America (ii) Eastern Side of Asia and Australia.

(2) Atlantic Ocean – 31,736,000 sq. miles, 82,217,000 km. It is in between Western Side of Africa and Europe, and Eastern side of North and South America.

(3) Indian Ocean – 28,364,000 sq. miles, 73,481,000 sq. km. It is South of India, and in between East Africa and West Side of Malaysia, Indonesia and Australia.

(4) Arctic Ocean – The temp. is so low that much of the Arctic ocean is permanently frozen. There is no solid land beneath the North pole. It is about 5,405,405 sq. miles.

(5) Antarctic Ocean — It is to the South of Indian Ocean and Pacific and Atlantic Oceans."

● THE OCEAN FLOOR

The Ocean floor has also many geographical features like that of land. It has mountain ranges, flat plains and deep trenches under the ocean. The longest range of mountains in the world is the underwater – Indian Ocean and Pacific Ocean. It stretches from East Africa, through the Indian Ocean, around the Southern Australia and across the Pacific Ocean to the gulf of California having a distance of 19,200 miles (300,900 km.) The deepest point in the Oceans, is the Mariana trench in the Pacific Ocean near Japan and is about 36,201 ft. (11,034 m.) below the sea level, it is deeper than the height of Mt. Everest, the highest Mt. on the world. The Pacific Ocean is the deepest Ocean in all the Oceans. The shallowest parts of the Oceans are the areas around the edges of the continents, which are called the continental shelves.

" THE EARTH'S FACT FILE —

(1) Mass	2.7155 × 10, 1b (5.9742 $\times 10^{24}$ kg.)
(2) Diameter	7926 miles, (12756 km.)
(3) Circumference	40,232 km.
(4) Rotational period	23.93 Earth hours, 23 hours, 56 minutes
(5) Orbital Period	365.24219 Earth days, Earth year
(6) Distance from the Sun	93 million miles, 150 million km. "

The Moon's rotational and revolutional periods are the same – 29 days 12 hours. 44 minutes. Hence the Moon always faces the same face towards the Earth.

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CHAPTER 3

MOVEMENTS UNDER THE CRUST

CONTINENTAL MOVEMENTS

● MOUNTAINS

Mountains are just like the wrinkles in the skin, on the Earth's surface. As per the movements of the plates and faults, there are changes in the Earth's crust that means the surface of the Earth. These movements are of different types. So many actions and reactions make various kinds of movements in the crust. The mountains of the world, are formed in different ways. Do you know that Himalayas, the tallest mountain range on the world, was once at the bottom of the sea ? Yes, it happened due to the colliding of the plates when the plates in the Earth's crust were pushed together. The Andese range in South America, which is the longest mountain range in the world, and the Alps which is at the North of Italy are formed by the same ways and are called fold mountains. There are many ranges of Alps in Europe.

Sometimes mountains are formed when the movements of plates inside the Earth create faults in the crust. As the plates press together, the mantle pushes its way upwards and the cracks are formed on the crust on the surface, and the land between the cracks is forced up above the surface level of the Earth, looking like a block shape and are therefore called block mountains.

The Great Rift Valley

The largest crack in the Earth's crust, stretching 5,400 miles from Syria in the North throughout the Red sea, Egypt to Mozambique in the Southern Africa. The scenery of the Rift valley in East Africa is most spectacular. In Kenya the walls of the

valley are almost straight up to 4,000 ft. high (1,250 km) Tourists from all over the world come to see the beauty and wild life in the valley.

EARTHQUAKES

We have seen that the surface of the Earth is unstable, constantly undergoing changes. These changes are caused due to internal processess of the crust. They give rise to slow and rapid both the movements of the Earth's surface. Rapid movements cause Earthquakes and Volcanoes.

Earthquakes mostly occur near the edges of the plates and trenches under the water, where there are cracks or faults in the Earth's crust. These regions are called earthquake zones which are on land and under the sea also. Earthquakes differ in their degree of intensity which is called Richter Scale. Sudden violent movements under the surface of the Earth is called earthquake. It is the shivering of the Earth's surface. Over many years, the plates slide past each other slowly, but sometimes the rocks get struck together and the intense heat is formed inside the Earth, which makes ground to shake for a few seconds and is called an earthquake. It makes a part of the Earth's surface to move backward and forward or up and down, in short in all directions these are the vibrations around the area. When it is with great force and intensity, the ground shakes very hard and the earthquake is very severe. Sometimes they cause widespread destruction.

Because earthquakes develop in the ground surface, some parts of the ground surface are raised while some parts subside. Everything on the ground – the buildings, the roads, the bridges, railways are smashed and there is a great destruction of wealth and heavy toll of lives. Thus earthquake can cause widespread damage. It can change the whole picture on the ground of that area. Rivers can change their courses or even disappear. Some new landslides also occur.

Volcanoes

Suddenly a fountain of fire bursts out of the Earth, showering with hot liquid rocks and clouds of dust and gas as if the Earth is spitting fire. This is the eruption of volcano.

At the edges of the plates there are cracks of faults in the Earth's crust, which are the weaker sections. Under the surface of the Earth, there is a mass of hot rocks and metals. In the mantle layer, it is so hot that the rocks melt and become molten rocks and they produce gases. The mixture of this gas and molten rocks is called magma. The magma rises towards the Earth's surface and collects in hollow spaces called chambers.

Near the edges of the plates there are cracks which are the weaker sections. Strong pressure underground, forces the magma through these cracks. When the magma bursts out a volcano erupts. The gases from the magma became part of the Earth's atmosphere and hot liquid called Lava flows over the ground. There are two types of volcanoes, central eruption and fissure eruption. Central eruption is called Andesitic volcanoes, they are very explosive and fearful. The fissure eruption is called the Basaltic volcanoes and are the gentle ones and regarded as tourists attractions.

Geysers

Some times gases leak out and heat up all water in the rocks near the Earth's surface. Then boiling water and steam is forced out in a jet called Geysers reaching heights upto 230 feet (70 m). Geyser bursts out of the ground near a magma chamber. These geysers are found mostly in the Andes range mainly in the Chiles regions and the region around Rotorua on the North Island of New Zealand.

THE MOVEMENTS UNDER THE OCEANS

Friends, you know that three fourth of our Earth's surface is covered with water. But do you know that land under the oceans is also made of mountains, valleys and flat plains like land on the continent? It even has volcanoes.

The continental shelf is the real edge of the continent, where the land slopes away to meet the sea bed, it lies about 200 metres below sea levels.

Ocean ridges are raised lines on the surface of the Ocean floor, where molten rock pushes its way up, from underneath the Earth's crust. A trench is a deep cut in the ocean floor. World's deepest trench is the Mariana trench in the Pacific. It is 36,201 ft. below ocean near Japan (11,034 m) and the wonderful thing is that the longest mountain range on the world is under the water under the oceans. It stretches from Indian Ocean near East Africa through Indian Ocean near Southern Australia and then through Pacific Ocean towards gulf of California in North America. It's length is 19,200 miles (300,900 km.)

Away from the continental shelf, near about 500 metres below ocean surface there is a plain sea-bed called the submarine plain.

Volcanoes can erupt of ocean ridges ocean trenches. Sometimes they may erupt above sea level and make volcanic island.

The water of the oceans always move. The surface of the water moves in waves and levels of the oceans rise and fall with the tides. Waves are caused by the winds

which blow across the surface of the oceans. We see that sometimes sea shores are completely covered with water, while sometimes, it is uncovered for long time, say about six hours or so. When seashore is completely covered with water, it is high tide and when it is uncovered it is low tide.

Tides happen because of the force of gravity. The gravity of the Moon, pulls the Earth's water towards itself.

Again the gravity of the Sun also pulls it towards itself. When, the tides happen, when the Moon is either "New" or "Full", the tides are the highest and are called spring tides, and then the difference between the level of water at high tide and low tide is very large. When the Sun, the Moon and the Earth are at right angle to each other the tides are called neap tides and the difference between the high and low tide is very small.

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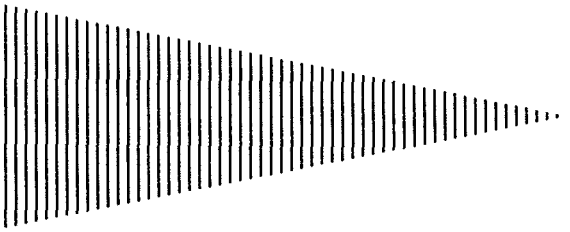
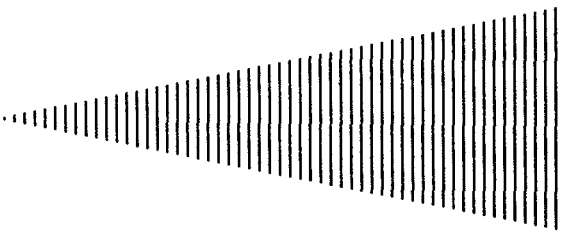


CHAPTER 4



GEOLOGICAL TIME

Our Earth started to form about 4-6 billion years ago, alongwith the formation of our Solar System. It is such a long period, that we can't even imagine it. So how to visualize a huge time scale like this ! The geological time of aging Earth ? It is almost a very difficult concept. The long periods involved in various geological times are almost impossible to understand.

But it is wonderful! Our geologists have invented a method to find out the date of geological times and events. Different periods of the era are mostly determined by the **ages of the rocks**. The oldest rocks are about 3.8 billion years old. Now, to make these times easier to understand, geologists talk about these times in terms of period and not in years. There are many different periods as studied by the geologists.

"These periods are grouped together to form different epochs, because the boundaries between the periods are based on the changes of fossils formed at these times. The periods apply only to the last 590 million years, before that the history of life is pretty vague."

"Then how are scientists able to put dates on geological events that happened millions of years ago? The secret lies in the radioactive isotopes of some elements. The scientists can fix a date for the formation of that rock. A radioactive isotope is an atom of an element, that can change spontaneously into an atom of a different element. Energy is released during this change. It is this process that produces power in an atomic power station. Every radioactive isotope changes or decays at a particular rate. Scientists can measure the amount of a radioactive isotope present in a rock. They then compare it with the amount of its daughter element. The daughter element is the substance into which it changes. These measurements tell how long the original isotope has been there. Thus scientists can fix a date for the formation of that rock". The extract is taken from the book "The secrets of the Earth" by Dougal Dixon.

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CHAPTER 4A

ROCKS

The continents are mostly flat in the middle and have mountains around the edges. North America is an excellent example. The solid parts of the Earth's crust are called rocks. Geologists can study the rocks of all the areas on Earth and find out the ages of the rocks. The study of rocks is very important. The scientists who study rocks are called geologists.

The flat areas in the centre are made up of hard old rocks that are millions of years old, as compared, the mountains around the outside are younger. According to geologists there are three main groups of rocks as per they were originally formed. They are (1) Igneous rocks (2) Sedimentary rocks and (3) Metamorphic rocks. All these rocks consist of minerals having different proportions in the same type of rocks in different areas.

Igneous Rock

The formation of igneous rocks takes place beneath and above the surface of the Earth. he rocks formed beneath the surface are called intrusive igneous rocks and those formed above the surface are called extrusive igneous rocks. Igneous rocks are the first rocks formed on the Earth's crust and are called primary igneous rocks. These rocks are formed as the molten rocky material hardens. Molten rocks burst from the mantle under the crust, then cool down and become solid. The most obvious occurrence of this rock is from Volcano, naturally it is born in fire. Molten lava flows out of an erupting volcano and then it is formed into solid wrinkled masses or jagged lumps. These are the extrusive igneous rocks as they are forced from the ground or they are extruded from the ground. Basalt is an example of extruded igneous rock. Heavy black basalt is extruded from shield volcanoes.

Rocks formed by the cooling of molten matter beneath the Earth's surface are called intrusive igneous rocks. This process of solidification takes place underground. Molten material from deep in the Earth may be forced into the rocks of the crust. But before reaching the surface, it solidifies in a mass. Such a mass may never appear at the surface. This rock is known as intrusive igneous rock. Granite and Gabbro are the examples.

Igneous rocks consist of tough minerals, we can see clearly crystal shapes and colours in these rocks, there are no layers and no fossils.

Sedimentary Rocks

It is because of the constant atmosphere movements on the land, rocks break up and wear out. They are transformed into smaller pieces and soil, and are carried away by river, wind and other agents, and are deposited in layers one above the other. Over a period of time, these layers become sedimentary rocks. Because, layers after layers are deposited, lower layers come under the great pressure and are compressed together and become hard. After that, because of the tremendous pressure exerted by the layers above, unified sedimentary rocks are formed.

Small pieces of rocks out of sediments are washed down into the sea, they settle there into layers. Over millions of years more and more layers press down each other and bottom layer becomes hard and is known as sedimentary rock and thus they are born in water or atleast moist air. Sometimes remains of dead plants and animals are trapped in between the layers of sedimentary rock and over a period of time those remain turn into stone, and are called fossils. There are three, four main types of sedimentary rocks. Lime stones are also a kind of sedimentary rocks.

Metamorphic Rocks

These are the new rocks formed from the old rocks. Sometimes igneous and sedimentary rocks are changed due to heavy pressures and extremely high temperatures, they are cooked and altered beyond recognition and third different kind of rock called Metamorphic is formed. It happens when there is intense heat and pressure underneath the Crust. Sedimentary rock and limestone can turn into metamorphic rock called Marble. Many times heavy pressure produces, what is called Regional Metamorphic Rocks. Great areas of the Earth's crust are altered in this way.

The surface of the centres of all the continents consists of very old metamorphic rocks. Below the surface, it is the igneous rocks that make up the greatest proportion of the Earth's crust.

● EROSION

Friends, we know that the rains, the water, the winds, the snow, the frost and all other weather conditions combined together, and act togetherly on the Earth's surface and it is because of this, erosion happens. Because of all these facts the rocks are eroded. The force of water, the winds, always move the sand, soil, rocks and pebbles from one place to another. Winds can make fall tall and sturdy trees from forests and then are weathered away forming themselves in wood and after thousands and millions of years into fossils. Some plants and animals are also trapped in-between the layers of sedimentary rocks and after millions of years they are also formed in fossils. These fragments – the pieces of shell, bone, wood are often found well preserved in sedimentary rocks. Sometimes a plant or animal leaves a hole in the rock in its exact shape and is called a mold. Ice also wears away rocks and soil as it freezes and thaws and this action is continued through out. Over thousands of years erosion can move mountains, dig out or fill in valleys and it can even change the directions of rivers. Thus erosion is Nature's actions and reactions, which process is also called weathering. There are two types of weathering — physical and chemical.

Physical weathering is mainly, what we have said above. Friends, we know very well that the highest mountains on the Earth, are really speaking the youngest features, while the older ones are much lower. Why is it so ? These older mountains were also very high, as high as todays high mountains, but it is because they are facing all the weather conditions for millions of years and are eroded and have become lower, now today. Some times rainwater seeps into cracks and pores in rock. In cold weather the water freezes and expands and the cracks are opened further. This process continues until the pieces of the rock break away. Sometimes loose stones are always carried away with large fast flowing rivers and over millions of years they erode a passage through solid rocks. The huge valleys they make out of this action which are called canyons. The Grand Canyon of Arizona in U.S.A. by the river Colorado is the best example of this. Flowing river water washes sand clay and soil down towards the sea. Sometimes where the river meets the sea, its main stream splits up into various streams and then they join the sea and this part of land is called delta or mouths or the river.

Chemical weathering is mainly due to rain water, when it is mixed with gases due to polluted air, factory chemicals, carbon dioxide which is common in the air and can become carbonic acid, and all those gases react with the minerals in the rock, when they are mixed with rain water and fall on the ground. These gases, which are now in the rain water mostly do the weathering of lime stones and also granite.

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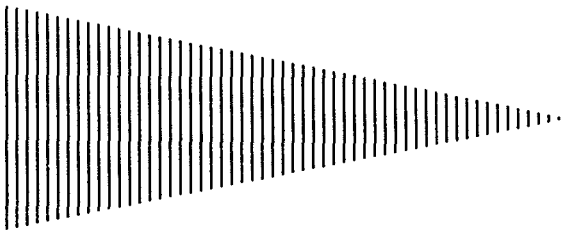

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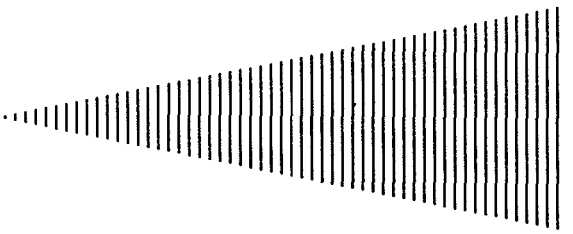

WEATHER

What is weather? We can say weather is really, air in different forms. Sometimes it is Sunny, Cold, wet or dry. This means weather is different at different times and at different places. Why so? It is because heat and light from the Sun travel through the Earth's atmosphere and the Sun's rays affect it in different ways, the Sun's rays affect the air in four ways. They can change the temperature that is the amount of heat it contains, they can change the humidity, the amount of water it contains, they can change the air pressure, the density of the air and they can change the wind, the way the air moves.

Temperature

Much of the heat the Sun gives is lost in the way while passing through space and only about one third of the sunlight reaches the atmosphere, and is again reflected back into the space by the clouds. And less than half the Sunlight which gets the Earth's atmosphere actually reaches the surface of the Earth. This Sunlight warms the ground and all forms of water that are on the Earth's surface and then reflect warmth back into the air.

Humidity

Humidity is the amount of water vapour that contains in the air. When Sunlight warms all forms of water on the surface of the Earth, water turns into water vapour. The vapour then rises into the air, condenses and forms tiny drops of water that float in the air as clouds. Then these drops fall on the Earth's surface as precipitation which means, rain, snow, hail or sleet.

Air Pressure

Warm air weighs less than cool air. Lighter weights that means the things which are light, put less pressure on whatever is underneath them. And so where there is warm air the pressure is low. Cool air weighs more, so where the air is cooler, the air pressure is higher.

Wind

The wind is air moving from one place to another. Air always moves from where the pressure is high to where the pressure is low. When there is great difference between the levels of high pressure and low pressure, the wind's movement is stronger. Winds are always named after the direction from which they blow.

● STORMY WEATHER

Clouds

Heat from the Sun turns water from all forms on the surface into water vapour. The movements in the air called convection currents push the vapour up in the air. It condenses then and turns again into tiny drops of water.

As you know, the air is full of tiny particles of dust and drops of water collect around the dust particles. The millions of these tiny drops gather and the clouds are formed.

Lightning

When the dark clouds fill the sky, heavy rain is pouring down, and bright flashes and noisy thunder crashes. This is the stormy weather.

During storm, strong winds make the clouds collide with one another. Each particle in the cloud has normally positive and negative electrical charge. Most of the positive charges move to the top of the cloud and most of the negative charges move to the bottom. Lightening is a giant spark of electricity in the sky. The spark happens when negative charges in a thunder cloud meet the positive charges in another cloud, or on the ground.

Thunder

Thunder is the loud noise made when hot air suddenly meets cool air, and a flash of lightening lights up the sky. It heats up the air around it so much that air reaches the 33,000 degrees celcius. When this air collide with cold air a giant wave of moving air makes the crashing sound of thunder. Thunder and lightening happen at the same time, but because light travels faster than sound, we see lightening first and immediately after some time we hear the thunder sound.

Dangerous Winds

The weather can sometimes be very dangerous, violent storm can create fierce twisting winds that seriously damage anything that comes in their way. There are different types of dangerous winds.

A tornado

A powerful twisting wind storm. It develops along a boundary called a front, where cool and dry air meet warm humid air and a black cloud forms in the sky. When this warm air rises very quickly the more warm air rushes and replaces it. As this air rises, sometimes it starts to rotate, the rotating air forms a tornado which stretches down from the cloud towards ground. If tornado meets the ground it sucks up the things like an enormous vacuum cleaner. It sometimes make houses explode.

A hurricane

A hurricane is a powerful whirling storm that starts over tropical oceans. Hurricanes are also called typhoons and cyclones. In tropical regions, warm air rises quickly above sea level, as it contains a large amount of water vapour that has already evaporated, from the seas below. Above the sea the water vapour cools, turns back into water droplets and forms storm clouds.

Hurricane winds rotate at very high speed of upto 420 kilometres a hour around the claim area in the centre, called the eye of the storm. Hurricane may last for several days moving forward at about 20 kilometres a hour. Most of the damage caused by hurricanes happen because the storm creates waves that flood on the land. Hurricane needs a continuous supply of moist air rising from warm seas. So once they reach the dry land hurricanes die out.

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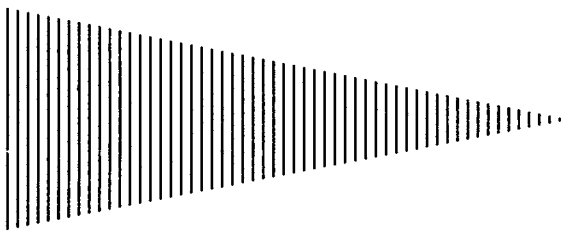

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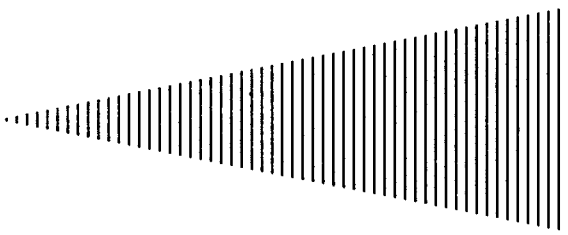

SEASONS, DAYS AND NIGHTS

We have seen that the Earth takes a year to circle around the Sun. It is the orbital period of the Earth and the Earth is slightly tilted on its axis (23-1/2°), so one hemisphere is always closer to the Sun than the other. This tilt causes the seasons. If Earth's axis would have been at 90° (right angle) there would have been no seasons. There are two hemisphere of the Earth – North and South which are divided by the equator exactly in the middle part or say latitude. The hemisphere tilted towards the Sun receives more heat and has summer while that which is tilted away from the Sun has winter and receives less heat.

The Earth also spins on its axis, that is rotating once every 24 hours. This rotation of the Earth causes days and nights. The side of the Earth facing the Sun has day while the other side has night. A day and the following night together make a Solar day. The Sun's rays are always perpendicular directly overhead on the equatorial region, and it receives maximum heat. As per North and South latitudes the Sun rays are slanting and become weaker and weaker as much of the heat of the Sun is lost while passing through space, because the distance of the North and South latitudes goes on increasing and at polar regions, they are too weak, because of the much more distance. Here the days and nights are of very long period – six months day and six months night. It happens because each pole is tilted towards the Sun, for each half of the year and the pole which is tilted towards the Sun has day while the other one has night. Thus there is six months day at one pole and at the same time six month's night at the other pole. Hence the polar regions are called "The land of Midnight Sun".

21st December is the longest day in the Southern hemisphere, and is called Summer Solstice, while in Northern hemisphere, it is the winter solstice, which is the shortest day there. It happens so, because in December the South pole is tilted towards the Sun and the Sun gets towards southern latitudes and on 21st December it stands overhead the tropic of Capricorn. The summer solstice is longest day while winter solstice is the shortest day. The situation is vice-versa in Northern hemisphere. The summer solstice for South and Winter solstice for North occurs on the same day.

Twice a year the Sun is exactly over head the equator. These days are called equinoxes, because on these days, the days and nights are of equal size, that means of 12 hours. March 21st and September 23rd are the two equinoxes. One is spring equinox and the other is fall (verbal) equinox.

● ATMOSPHERE

While studying the Solar System, we have seen, how and when our Earth was formed. Our Earth is the third planet from the Sun, having the distance of 93 million miles (150 million km.). The size of the Earth is exactly as it is required and the distance between the Earth and the Sun is also the same as it is needful, to have a life on it. If both these aspects would not have been the way they are, life would not have been possible on Earth. If our Earth would have been little smaller or little bigger, the distance between the Earth and the Sun would be little lesser or little larger than it is, life would not have been possible on Earth. Our Earth is just right to have a life on it, because of its distinct and peculiar position which no other planet has.

Our Earth has an atmosphere consisting of five layers of gases surrounding it, and is roughly 120 miles thick. It is because of this atmosphere life is possible on Earth. The atmosphere comprises of nitrogen 78%, Oxygen 21%, and carbon dioxide, water vapour and small amount of other gases. The five layers of the atmosphere are —

(1) The Troposphere — the densest and closest layer
(2) The stratosphere or Ozonosphere, a part of stratosphere
(3) The Mesosphere — the middle atmosphere
(4) The Thermosphere
(5) The Ionosphere (part of Thermosphere)

The atmosphere becomes thinner and thinner at the higher altitude and above Mesosphere, it becomes very thin. The Earth's atmosphere acts as a modulator and serves to shield the Earth from much of Sun's radiations which are harmful and

poisonous. The infrared and radio waves are absorbed and blocked by the stratosphere. Ultra violets Radiations are almost entirely blocked by the Ozonosphere, which is there in the stratosphere and x-ray do not penetrate the atmosphere. Actually height level of atmosphere could be considered upto all the five layers which is 620 miles. But last two layers being very thin, there is very little distinction between these layers and the space and so the height of the last two layers is not taken into consideration as atmosphere and only upto Mesosphere which is 120 miles, is considered as atmosphere.

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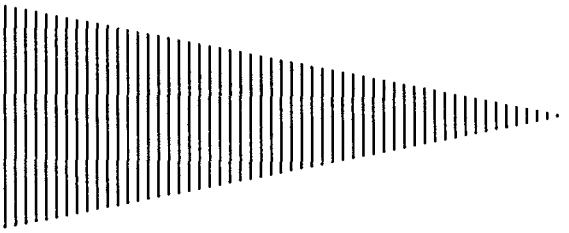

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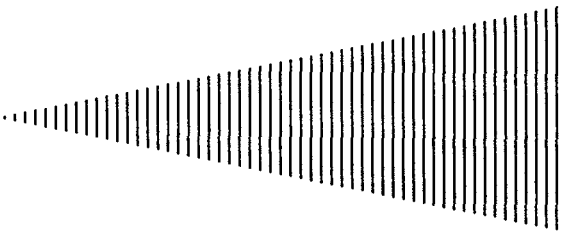

ICE AGE

In long past there were several Ice Ages, during the periods, huge sheets around the North and South poles were used to be much bigger than they are today. They covered even much of the area of North America, North Europe, North Russia, Greenland and of course some tiny islands that come under the region today. During each Ice Age the ice advances and retreats several times and each advance of ice lasted for about 1,00,000 years.

At both North and South poles, it is so cold, that there is no summer in real sense the snow or ice can never melt. New deposition of snow is often there when snow falls, due to its heavy pressure, tightly packed layers of snow form into ice. And over a period of years this ice becomes ice sheets. Some areas of the Earth are covered with huge ice sheets and snow, throughout the whole year. They cover north parts which are known as Arctic circle, and much more to its south parts and also to the north parts of Antarctic circle.

Glaciers

When there are high mountains the regions of tops and peaks are mostly covered with snow and ice. Many times a river of the ice which is actually formed of ice sheets flow down a valley and this ice river is called a glacier. Glaciers begin at small hollows on the mountain side. Every year fresh snow, falls into these hollows. Every day and night the freeze thow process goes on and because of this process when the layer of ice becomes very heavy it starts to flow out of the hollow and down to the valley. Here it is called glacier and it moves down hill. When glacier reaches the lowlands where the air is warm enough for the ice to melt, the glacier looses ice form

and becomes water. Glaciers can move at different speeds at different places as per the region, it can be a few centimetres to about 200 centimetre every year.

Ice bergs

Ice bergs are huge lumps of floating ice in the sea. It's a very huge lump of ice under the water, but only a small portion is seen, is visible above the water that is only 1/10 of the whole ice berg. Because the huge parts of ice bergs are hidden under the water, they are very dangerous to ships passing through the Arctic and Antarctic seas.

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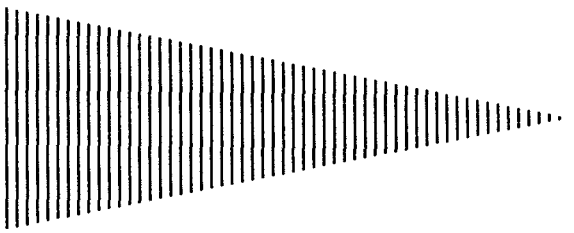

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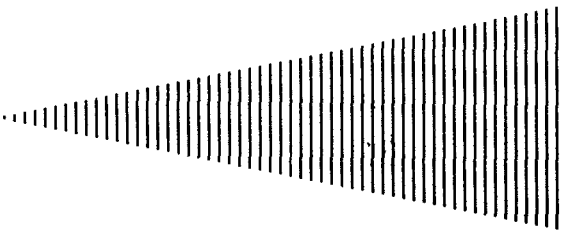

EARTH'S WEALTH FROM CRUST AND OCEAN

Everybody knows that the sea or ocean water is always salty. Do you know why? Sea water contains such a lot of salt that it makes it very unpleasant and aweful to taste and very unhealthy to drink. Over the period of years, people are collecting salt separating it from sea water for their use. Even then it does not become less it remain as it is. However in some parts the degree of saltness differs. How ? It is because, this salt comes from some rocks in the deep sea, where the root salt acids are there and the formation of salt is always going on continuously.

In Polar regions, the sea provides sea food, which is the only main food. Again, it is said that every natural element can be found in the sea.

Everything on Earth is made of combinations of chemical elements, which are mostly metals, and with the combination of other elements, they are formed in compounds, which are called minerals, when they are found in rocks and soil. We can find such a great variety of range of minerals from Earth's crust. So many types of metals that can be used for various purposes such as business, domestic purpose, medicines, even precious metals and stones and what not?

The Earth even provides food from vegetation and farming. It takes care of all species of life living on it. Hence our Earth is just like a mother who produces and provides everything that is needful for all the species of life on it.

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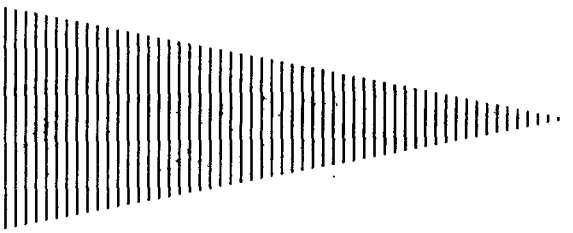

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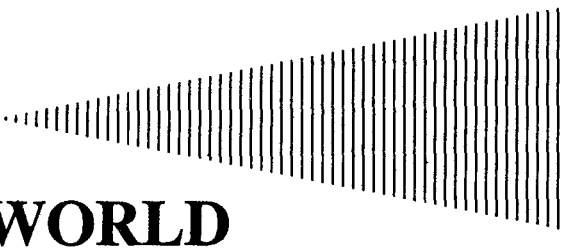

THE EARTH? OF COURSE THE WORLD

While studying the Earth we have to learn the maps and globe of the Earth's surface in miniature.

Globe represents the whole surface of the Earth in its correct spherical form in miniature. Maps are conventional delineation of the Earth's surface on a portion thereof on the flat surface.

Alongwith geology, we have to learn geography also to some extent as both the subjects go hand in hand. And henceforth we cay say, **world** instead of **Earth**.

Geographers have drawn imaginary lines around the globe of the world, to help to locate the places in the world. Lines of latitude circle the globe from East to West and are measured in degrees North and South of the equator. Lines of longitude circle the Earth from North to South and are measured in degrees East to West of the line called Prime Meridian (Greenwich London). Equator could be said a line of latitude which circles around the Earth and makes exactly two equal parts of the Earth, called North Hemisphere and South Hemisphere.

Two main lines of latitudes in Northern Hemisphere are called The Tropic of Cancer and the Arctic circle. In the same way two main lines in Southern Hemisphere are called The Tropic of Capricorn and the Antarctic circle. All these lines divide the world roughly into Polar, Temperate and Tropical zones.

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CHAPTER 9

MAP OF THE WORLD

● HOW THE WORLD IS STRETCHED

Friends, it is impossible to study the world as a whole, we have to study it part by part. We have already seen the facts and figures as per continents and oceans. According to the world map, the whole world could be seen in four parts (1) The Arctic circle in the extreme North, having North Pole in the centre (2) The Antarctic circle in the extreme south having south pole in the centre (3) Accordingly to the usual map of the world, having Atlantic Ocean in the centre and the Pacific Ocean being divided into two parts at two ends West and East of the map.

We know now that at both North and South ends lie Arctic circle and Antarctic circle having both the North Pole and South Pole at the centres. Under the Arctic Ocean no land is there and the ocean is frozen throughout the year. Arctic circle covers the Northern parts of Canada, Europe and Asia – the Siberia, including most part of Greenland and some tiny islands. The Antarctic circle is the South Pole region. Here lies the continent Antarctica which is covered by heavy ice sheets with great depths throughout the year. Antarctic Ocean surrounds the continent. No human can live here permanently.

Both North and South America are in the Western Hemisphere and they stretched from the North most to the South most parts of the world.

● NORTH AMERICA

Some of the north parts of the North America lie in the Arctic circle only, then there is the 2nd largest country in the world, the Canada to the south of it, is U.S.A.,

which means United States of America, many states comprise the country and is called U.S.A. But when we say America in general, it indicates U.S.A. Alaska lying to the West of Canada is also a part of U.S.A. Then is the country of Mexico to the South of U.S.A. Then there is a narrow and long region called Central America, which joins the two continents North and South America. Adjacent to it, on the east are Gulf of Mexico and the caribean sea, which consists so many islands. The caribean Islands which are also called West Indies. The Panama Canal which joins the Pacific and Atlantic Oceans lie in the region of Central America.

Northern Canada is covered by vast areas of forests and Tundra region while the west is dominated by Rocky Mountains. There is a great lake like Hudson Bay. The other lakes, the Lake Superior, the Lake Michigan, the Lake Huron, the Lake Erie and the Lake Ontario lie on the boundaries of both the countries Canada and U.S.A. ***The world famous Niagara Falls, falls from the lake Erie to the Lake Ontario*** and this has been situated on the borders of Canada and U.S.A. To the east of Canada is Labrador to north is Greenland, most part of which lie in Arctic circle. Alaska lies to the northwest of Canada having mountain ranges of Alaska and Brooks and also other mountainous region. Though Alaska is near to Canada it is a part of the country U.S.A. United States is made up of 50 states and is one of the largest and is the richest country in the world. It is dominated by two main mountain ranges, the Appalachians in the east and Rockies in the west, as also some other ranges are in the west. Amongst these mountain ranges there is a region of vast plains. Mexico has also the Mountain range of Sierra Madre Occidental. Thus the most of the parts of west of north America are dominated by mountainous region. There are many big rivers but Mississippi and Missouri are the important ones. River Colorado is having ***a Grand Canyon of Arizona*** which is also world famous. To the west of the continent is the Pacific Ocean and to the east is the Atlantic Ocean.

Then to the south is the continent South America.

● SOUTH AMERICA

It is the long region and stretches from Caribean Sea in the north, crossing equator and tropic of Capricorn, towards the extreme end of the continent — ***Cape Horn,*** which is also ***the south most city of the world*** except Antarctica, it lies only 620 miles north from Antarctica. To the west of the continent is the Pacific Ocean and to the east is the Atlantic Ocean.

The continent of South America is made up of great mountain ranges, big rivers, their basins, thick forests, wide plains and deserts. ***The world's longest mountain range the Mount Andes lies parallel to the full west coast of the continent***

and is 4474 miles long. There are snow-capped peaks of Andes which are amongst the most recently formed mountains and have many volcanoes some of which are quite active. The extensive basin of river Amezon, which is quite big and large river, lies across the equator is a hot and wet region and contains the largest tropical rain forest in the world. ***The highest fall in the world, Angel Falls 979 m. is in Venezuela.***

The countries in the continent are, Colombia, Ecuador, Peru, Bolivia, Chile, Argentina, Uruguay, Paraguay, Brazil, French Guiana, Surinam, Guyana, and Venezuela.

● AFRICA

Then towards east, Atlantic Ocean is stretched from north to south. Then the continent of Africa lies in both northern and southern hemispheres and the Indian Ocean lies to the east of Africa and an island Madagaskar is adjacent to the South Africa and there are some tiny islands nearby. And to the north of Indian Ocean, there is an Arabian sea and crossing over India lies the Bay of Bengal. Towards north of Africa lies the Mediterranean sea and towards northeast lies the largest continent in the world the Asia.

The continent of Africa is the second largest continent in the world, as it stretches from the north of tropic of cancer to the south of tropic of Capricorn, it has much of the equatorial region and is the warmest of all the continents. The highest peaks of Mount Kenya and the Mount Kilimanjaro are the only places where permanent snow and ice is found. In the regions near equator the hot and wet climate supports the dense jungle vegetation of the tropical rain forests. Vast basin of river Kango is the best example. There are many big rivers and ***the river Nile in the East Africa is the longest river of the world.***

Moving away from the equator, the climate becomes increasingly dry and instead of forests, there are tropical grassland called Savannah. For thousands of years Savannah has supported the plant eating animals along with the wild animals who hunt and feed on them.

Still further to the north and south lie the great deserts, here the climate becomes very hot and in the northern region lies Sahara, the world's largest desert and in the south lie Kalahari and Namib deserts.

Africa has an immense plateau broken by a few mountain ranges. In some areas a narrow coastal plain stretches along the edge of the plateau. Cutting across East Africa is ***the Great Rift Valley*** with its many lakes and volcanoes. This long valley

stretches from Syria through Red Sea to Mozambique. It is the ***biggest Rift valley in the world,*** about ***6000 km. long.*** It was formed centuries ago when land slipped down between huge cracks, in the earth's crust. Some scientists believe that the east of Rift valley will eventually break away from Africa and become a new continent.

The Mediterranean sea and Red sea are connected by the Suez Canal. Considerable international traffic is carried on by this route. The Suez Canal has provided a shorter route from Asia to Europe and has reduced the distance between India and Europe.

After Africa, to the north is Europe and towards east is the largest Continent Asia, and in between three continents — the Africa, the Europe and the Asia lie the Mediterranean Sea. The regions around the Mediterranean Sea has hot dry summers and cold wet winters. There are some small islands in the Mediterranean sea. The sea helps for traffic through Suez Canal, which is in between North Africa, and Saudi Arabia.

● THE EUROPE

Europe is the second smallest continent as per area. It has been surrounded by three sides by water, having Arctic Ocean to the north, Atlantic Ocean to the West and Mediterranean Sea to the South. It has only land frontier with Asia, which is marked by the Ural Mountains in U.S.S.R.

(1) British Isles

Lie off the North Western Coast of the mainland of Europe and there is an English Channel in between the two. During 18th and 19th Centuries the United Kingdom was the first country in the world to go on industrial revolution and had made wonderful progress. Even today also some countries in Europe have a leading part in some industries. It consists of two large islands Great Britain and Ireland surrounded by some small ones.

(2) France

Pyreness Mountains are to the west of France and to the east of Spain it divides the two countries spreading out from north to south, again the ranges of Alps have been spread out to the east of France along with the countries of Switzerland, Austria and Italy. France has a very long coastal area of having Atlantic, English channel and Bay of Biscay surrounding its coasts. Landscape of France differs very much from region to region, there are rich farmlands, dry hot, areas snow capped mountains and large forests.

(3) Benelux

Belgium, Netherlands and Luxemburg are togetherly known as Benelux. They are situated on the North European plain, where the land is mostly flat and low lying and are sometimes called "low-countries". The high land of hilly Ardennes forest is only the higher region in Southern Belgium and Luxemberg.

(4) Scandinavia

The Scandinavian countries are Norway, Sweden, Denmark and Finland, situated in the North Europe and some of the Northern parts of the countries lie in the Arctic Circle. Iceland also is under this group which is situated in the North Atlantic Ocean. The landscape of Scandinavia varies from country to country. Denmark is low lying and much of its land is used for farming whereas whole of Norway is Mountainous and ***the country's coastline is dotted with long narrow bays called fjords.*** Finlands has forests and lakes, while Sweden has an extremely varied landscapes which includes forests, lakes, farmland and mountains. The Central part of Iceland is a plateau of volcano, lava fields and glaciers. Hence, people live around the coast.

(5) Germany, Austria and Switzerland

The landscape in this region varies greatly. It changes from the plains to the north, to high mountains to the South. It is crossed by two of Europe's longest rivers – Rhine which flows north wards and joins the north sea, and the Danube which flows east-wards and joins the Black Sea. South of Germany lie the mountainous countries of Austria and Switzerland, tourism, is an important source of income, people from all over the world are attracted towards these Alps mountain ranges.

(6) Italy

Italy is a boot shaped country which is thin and 500 mile (800 km) long Peninsula in southern Europe, which stretches south into the Mediterranean sea. Most of landscape is hilly or mountainous. In the north the snow covered Alps form a barrier between Italy and rest of the Europe. Towards south of the country are Apennines, rugged mountains. The Mediterranean islands of Sicily and Sardinia are also parts of Italy.

The Vatican city in Rome is the world's smallest independent state. The Vatican is the center of Roman Catholic Religion. It contains St. Peter's Basilica, the biggest Christian Church in the world.

(7) Spain and Portugal

The countries occupy a large square block of land called Iberian Peninsula, in south western Europe. It also contains the tiny independent state of Andorra and the British colony of Gibraltar. Pyrenees is in-between Spain and France.

(8) The Central and Eastern Europe

Many countries like Poland, Czechoslovakia, Hungary, Romania, Yugoslavia, Bulgaria, Albania and Greece along with island create in the Mediterranean sea lie in this region. But the boundaries between these countries have changed many times. After the IInd World War except Greece all these countries became part of "Eastern Block" They had communist government and strong links with U.S.S.R. Afterwards recently also many of them have become independent and have changed their boundaries, as per their history.

● ASIA

Asia – Russia and America – Alaska

In the North, in the Western hemisphere there is a Bearing strait in the Bearing sea. Here the two ends of the two countries Russia and Alaska meet, in between Chukotskly Poluostrov in Russia and Seward Peninsula in Alaska. Thousands of years ago, there was no strait and the land was joined, it is wonderful that so many Asians migrated to America through this land during that ancient period.

Russia

Russia is a very big, the largest country in the world. U.S.S.R. was stretching across two continents — the Europe and the Asia. The Ural mountains divide them in two parts. Europe to the West and Asia to the East. Sometimes both of the countries are called "Uresia". The European part occupies only 25 per cent of the land of the country, even then 70 per cent of the people live there. While most of the Russian part even being a large land of the country is uninhabited. This huge part or region which lies on the east side is called Siberia. Geographically Siberia is divided in three parts. After Ural mountains towards east, there is west Siberian low lands, Central Siberian uplands and lastly east Siberian uplands. Thus the whole region is mountainous as well as world's biggest plain also, to the north there are almost snow covered regions in winter and in summer grass or wheat grow in plains. Being very huge country, it has almost all types of climates and crops. There are many big rivers also.

U.S.S.R. was occupying 15 republics and many other small countries, which have different types of regions and people of different races. There is a world's

largest forest — a vast area of coniferous trees, stretching from Baltic sea to the sea of Okholst.

South Western Asia

This region is also known as Middle East. It lies amongst three countries, Asia, Europe and Africa. It has many varied landscapes and cultures. The countries surrounding the Mediterranean are wetter than others. To the south stretches the huge desert of Saudi Arabia. In the countries around the Persian Gulf the world's largest deposit of oil were discovered in the early (20th century). The oil fields in the region now supply oil to the world. These oil discoveries have changed the life of people, the countries have now become amongst the richest countries in the world. Tigris and Euphrates are the main rivers in the northern regions like Syria, Iraq and Jordan. In the Middle East, **Jerusalem** is the holy city of three religions, Judaism, Christinanity and Islam.

● SOUTHERN-ASIA

The largest country in the Southern Asia is India and the region is often called the "Indian Sub continent". Most people in Southern Asia live, in the wetter areas on the coasts and on the fertile plains of Indus and Ganges and Jamuna rivers. There are many other big streams of rivers which join these rivers. Again in the middle part of it is the river Narmada and to the south are the rivers like Godavari, Krishna and Kavery. Towards East are Brahmaputra, Mahanadi and Iravati in Myanmar (Burma). All these rivers make the region very fertile. In 1947 India was divided into two countries with different religions. Muslim Pakistan and Hindu India. Actually India is a secular state having different religions.

To the North East of India lies ***the world's highest Mountain ranges Himalayas.*** It has several ranges and stretches from North as Hindukush, Karakoram and to the North East as Himalayas. There are more than forty highest peaks in the world in Himalayas and the highest of all being Mt. Everest 29028 ft. Himalayas are surrounded by India, Pakistan, Tibet and China, and to some extent Afghanistan also.

In India there are some other mountain ranges also. Aravali in North west, Vindhya and Satpouda in the middle and Western Ghats (Sahyadri) alongwith West coast and Eastern Ghats on the East side. India has a great coastal area along with Arbian sea, Indian Ocean and Bay of Bengal. Really speaking India is a peninsula having waters on three sides and attached to the land on north side. To the South of India is a small island called Sri Lanka, which is an independent country. To the South of India lies the Indian ocean which stretches towards Antarctic circle.

Cherrapunji in Northeast India, receives the highest rainfall in the world.

● THE SOUTH EAST ASIA

The equator crosses South East Asia, and so it is always hot, heavy tropical rainfall and rainstorms are common. The mainland and most of the islands are quite mountainous and the mountains are covered with thick tropical forests. The areas are difficult to have life and naturally population is scarce. The large rivers are important routes and their vallies and deltas are crowded ones.

Indonesia

Indonesia is the biggest country in the region. Indonesia consists of many islands like Java, Sumatra, South part of Bomeo, West part of New Guinea and other islands. Most of its parts lie in Southern Hemisphere.

Philippines

The Philippines is a large group of tiny islands.

Malaysia

Malaysia includes part of main land and most of northern Borneo.

Myanmar

Myanmar is in between to the east of India and west of China and was a part of India, before.

Thailand

Thailand has always been independent and it used to be called Siam and is situated to the south east of Burma (Myanmar)

Vietnam, Laos and Cambodia

Vietnam, Laos and Cambodia are to the east of Thailand and Vietnam has a quite considerable coastal area in South China Sea.

Singapore

Singapore is an island at the tip of mainland of Malaysia but is a separate country formerly it was a part of Malaysia, since it has become independent country, it has made a tremendous progress and has become a tourists attraction.

Brunei

Brunei is the tiny oil-rich country.

● CHINA AND NORTH EASTERN ASIA

China is number one in population in the world, and is world's third largest country. after U.S.S.R. and Canada. There are many high mountains in China, such as rugged mountains of the south west and the huge plateau of Tibet. There are amazing limestone mountains in southern China, and is a tourists attraction. Then in the north, there is a big desert namely Gobi, in Mongolia, nearby China. The lower part of eastern China has wet climate and the region being fertile plains because of many rivers has been much crowded. The rivers like Yangatze, Huang-He, Si-Kiang are the main rivers. China has developed many industries.

Tibet

Tibet lies in the highlands of south west China at an average height of 14,800 ft. (4,500 m) above sea level. This is higher than most of the mountains in Europe and United States. It can be said as the world's highest plateau. The Himalayas, the world's highest mountains stretch along the border of India, attaching to Tibet's plateau.

Mongolia

Mongolia is to the north of China and South of Russia Siberia. It has some highlands, some plains and some grasslands. Then there is a huge desert of Gobi in the inner Mongolia. It is the world's emptiest country. People here are fewer than 3 million very little as compared to the area of the country.

Taiwan

Taiwan is an island to east of China in Philippine sea and is the independent country.

Korea

Korea is to the north eastern region of China, to the east of Mongolia. It is divided in two parts north and South Korea. Korea is a peninsula amongst the seas of Japan, Yellow Sea and Korea strait.

Japan

Japan is made up of four main islands called Hokkaido, Honshu Shikoku, Kyushu and thousands of smaller ones, even though it is quite a small country it has a very big population — about 124,000,000. This is five times as much as Canada which is the second largest country in the world.

The country lies to the north east of the main part of Asia, where two plates of the Earth's crust meet making earthquakes common. Nearly three quarter of the

country is mountainous and wooded. Mount Fuji is Japan's most famous mountain and an old volcano, 12,000 ft. high. There are some other volcanoes also. In winter the upper slopes of the mountains are snow-covered. Japanese have become the world's biggest producer of electrical and electronics goods, televisions, ships and many others. Japanese cars and computers are admitted world wide.

Much of the land of Japan cannot be used for farming hence Japanese eat lot of fish. They catches more fish than any other country, Being a country of islands surrounded by seas and having a very little land for farming, as much of its land is mountainous.

Japan is the country where the Sun rises first of all other countries in the world.

● OCEANIA (AUSTRALASIA)

The continent Oceania is the smallest one in the world which lies in the Southern Hemisphere on the east side, and has fewer people than any other continent except Antarctica. It is also called Australasia, after Australia, which is the only large piece of land, it also includes the islands of Papua New Guinea, New Zealand, Tasmania and thousands of tiny islands scattered across the Pacific Ocean.

Over millions of years ago, Australia, New Guinea, New Zealand were joined to the other Southern continents, but they split off and drifted away into the Pacific Ocean. Because the continent is isolated the unique plants and animals found there, are not found anywhere in the world.

The islands in the Pacific Ocean have been formed in a various ways. Some of them are the tips of mountains or volcanoes which rise up from the ocean bed, while others are formed of coral, made up of the skeletons of millions of tiny sea creatures. **The Great Barrier Reef** is a maze about 2,500 reefs and islands stretching 1,200 miles (2000 km) along the coast of Queens land.

The Aborigines of Australia are there from about 40,000 years ago. Most Australians now, are the people from Europe who migrated there in the last 150 years.

Australia has mountain ranges along the east coast as also the west and north and in the middle region. So the country is mountainous has plains and also deserts. People live mostly in towns near coasts.

Antarctica

The Southern most part of the world is the continent, Antarctica, which is always covered with thick ice sheets with great depth for the whole of the year.

Pacific Ocean

Then the Pacific, the largest ocean is being divided in the centre as East and West Pacific, where the view of Pacific Ocean is interrupted.

There are thousands of small and tiny islands scattered across the Pacific Ocean but being divided in the middle part we are unable to have a full and correct view of the Pacific Ocean.

We can have the world's map in other way, where instead of pacific being divided, Atlantic is divided and can have the full view of the whole of the pacific in centre, without any interruption.

Note: The chapter is predominantly referred by the Atlas Book
"Rand Mc. Nally Picture Atlas of the World"
Illustrated by Brain Delf.

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CHAPTER 10

IMPORTANT MOUNTAIN RANGES AND HIGHEST PEAKS

● ASIA

Himalayas

Himalayas are the Mightiest Mountain ranges, as if they are touching the skies, as if they are taking us to the Heaven! It is the **highest** mountain range in the world! Himalayas spread out in many ranges from northeast to the south east of India. Tibet is the highest plateau attaching to Himalayas. India, Pakistan, Nepal, Tibet and China even Afghanistan at Hindukush range are surrounding it. Himalayas are the most recent one and geologists believe that the height of the Himalayas is still increasing! It consists of more than about first 40 highest peaks of the world!

The Highest Peaks —

(1) Mt. Everest	29028 ft, 8848 metres – Nepal and China
(2) Mt. K2 – Qogir-Feng	28250 ft, 8611 metres – Karakoram – Pakistan – China
(3) Mt. Kanchanjunga	28170 ft, 8596 metres – India - Nepal
(4) Mt. Makalu I	27824 ft, 8470 metres – Nepal
(5) Mt. Annapurna	28053 ft, 8078 metres – Nepal
(6) Mt. Dhaulagiri	26810 ft, 8122 metres – Nepal
(7) Mt. Nagaparbat	26660 ft, 8126 metres – India
(8) Mt. Gosainathan-Shisha Pangma	26291 ft, 8103 metres – Nepal

(9) Mt. Cham-lang	25730 ft, 7917 metres	– Nepal
(10) Mt. Nandadevi	25402 ft, 7816 metres	– India
(11) Gorila Mandhata	7728 metres	– Tibet
(12) Mt. Kamet	7700 metres	– India
(13) Mt. Kunkun	7135 metres	– India
(14) Mt. Kailash	6714 metres	– Tibet + China

There is a Kailash range also in Himalayas. Mount Kailash, is a very sacred place for Hindus, it is supposed to be the dwelling place of Bhagwan (Lord) Shankar.

There are many other peaks which have very similar heights with a very little difference but it is impossible to state all of them here.

● II. SOUTH AMERICA

Andes: Andes is the longest mountain range in the world. It stretches from caribean sea in the north, to cape Horn, the south most city of the world in the south, at the full west coast of South America. Its length being 4474 miles. It is also most recent and too many volcanoes and earthquakes often occur there.

Highest Peaks —

(1) Mt. Acocague	22834 ft, 6960 metres	Argentina
(2) Mt. Illimani	22579 ft, 6402 metres	Bolivia
(3) Mt. Huscaran	22205 ft, 6779 metres	Peru
(4) Mt. Bonet	22564 ft, 6872 metres	Argentina
(5) Mt. Yerupaja	ft, 6634 metres	Peru
(6) Mt. Nev Sajama	ft, 6542 metres	Bolivia
(7) Mt. Muoo Coropuna	ft, 6425 metres	Peru
(8) Mt. Ojas De Salado	16763 ft, 5910 metres	Chile
(9) Mt. Cotopaxi	19347 ft, 5897 metres	Equador
(10) Mt. Liecan Cobur (Volcano)	19425 ft, 5910 metres	Chile

Some other highest peaks

(1) Mt. Tupungato	6800 metres	Argentina
(2) Mt. Merceadrio	6770 metres	Argentina
(3) Mt. Illampu	6485 metres	Bolivia
(4) Mt. Card Huanzo	6495 metres	Peru

(5) Mt. C De. Olivere	6282 metres	Argentina
(6) Mt. Nav De. Ampato	6310 metres	Peru
(7) Mt. Nav De. Chachani	6078 meters	Argentina

● IIA. NORTH AMERICA – MOUNTAIN RANGES

(1) Brooks and Alaska Ranges in North America in Alaska

(2) Rocky Mountains, Coast Range, Cascade Range on the west coast side, stretching along north to south from Canada to Maxico.

(3) Sierra Madre Occidental, it stretches on the west side of Mexico.

(4) Appalachain Mountains on the east side of U.S.A. Thus North America has been surrounded by mountains and in the middle there are plains.

The Highest Peaks

(1) Mt. Mekinley	20320 ft, 6914 metres	Alaska
(2) Mt. Logan	19849 ft, 6050 metres	Canada
(3) Mt. Rainer	14409 ft, 4392 metres	Washington State
(4) Mt. Whitney	14494 ft,	Washington State
(5) Mt. Citlatepeti	18701 ft, 5699 metres	Mexico
(6) Mt. Popocatepeti (Volcano)	17887 ft, 5462 metres	Mexico

Some other highest peaks

(1) Mt. St. Ellas	5489 metres	Alaska
(2) Mt. Foraker	5304 metres	Alaska
(3) Mt. Bona	5005 metres	Alaska
(4) Mt. Sanford	4950 metres	Alaska
(5) Mt. Nav De Toluka	4577 metres	Alaska

There are many other peaks which have very similar heights but all of them can't be stated here.

● III. AFRICA

There are some mountain ranges like Kenya, Kilimanjaro and also in Ethiopia in east Africa, but are not very high. There are only three highest peaks that are worth mentioning.

The Highest Peak

(1) Mt. Kilimanjaro	19344 ft, 5895 metres	Tanzania
(2) Mt. Kenya	17057 ft.	Kenya
(3) Mt. Ras Dashen	15158 ft.	Ethiopia
(4) Mt. Marqherita	16,765 ft.	
(5) Mt. Cameroon	13,484 ft.	

● IV. EUROPE — ALPS

There are so many Alps ranges spread out, throughout the South Europe and each range has a separate name suffixing Alps, such as Dynaric Alps, Apennine Alps and so on. It's height, maximum to about 12,000 ft. to 14,000 feet. Beings at the North latitude it is already a cooler region and snow-line of Alps is much lower than that of Himalayas and Andes. (Andes has lower snowline at the south most part of it, where it is very towards the southern part of the world, the south most latitudes) Hence because of the lower snow-line. Alps peaks are always covered by snow and ice, and it has become very popular amongst tourists. They can enjoy the scenery, the weather and sports as well. Whereas at Himalayas no one can enjoy like this. Only the brave mountaineers are interested in reaching and capturing the high peaks, which is the most difficult and tedious job. At Andes though it is not as high like Himalayas, it is some what like the same case. Thus the Alps have become the most popular amongst tourists.

The Highest Peaks —

(1) Mt. Blanc	15770 ft, 4807 metres	France + Italy
(2) Mt. Monte Rosa	15203 ft, 4634 metres	Switzerland + Italy
(3) Mt. Matterhorn	14691 ft, 4478 metres	Switzerland + Italy
(4) Mt. Jungfran	13641 ft, 4158 metres	Switzerland
(5) Mt. Gran Paradise	13410 ft, 4081 meters	Italy
(6) Mt. Vesuvius	1277 ft, 4190 meters	Italy
(7) Mt. Musala	9596 ft, 2920 metres	Bulgaria
(8) Mt. Olympus	9570 ft, 2917 metres	Greece
(9) Mt. Viso	3841 metres	Italy
(10) Mt. Elbrus	18481 ft,	Caucasus-Georgia-Europe

● V. RUSSIA

In Russia, or we can say better in Siberia, most of the regions are highlands and some mountain ranges are also there but they have very low levels. There is only one highest peak to the south most part, in between China and Afghanistan, which is quite high.

The Highest Peak — only one

(1) Kommunizma (communism peak) 24596 ft, 7495 meters

● VI. CHINA

China has some mountain ranges and uplands but no considerable high peak.

● VII. JAPAN

Japan has some mountain ranges which consist many volcanoes, but the only Mt. Fujiyama has somewhat considerable height and is the famous volcano.

Highest Peak – Only one

(1)Mt. Fuji (Fuji Yama) 12388 ft, 3776 metres

● VIII. AUSTRALIA AND NEW ZEALAND

There are some mountain ranges along with coastline, but no considerable high peak in Australia. Only in New Zealand, on the island named South Island, there is one high peak.

(1) Mt. Cook 12349 ft, 3764 metres New Zealand, on South Island.

All the highest peaks and figures are referred from the Atlas books

(1) Rand Mc. Nally Picture Atlas of the world – by Brain Delf
(2) The facts on File Children's Atlas – by David and Jill Wright.
(3) Pictorial Atlas of the world – Ottenheimer publishers, Inc.
(4) The Oxford School Atlas – O.U.P. – Delhi – Bombay, Calcutta Madras 1982

● THE IMPORTANT RIVERS

NORTH AMERICA	— Mississipi 2,348 miles 3,778 Km. — Missouri 2,315 miles 3,726 Kms. — Rio-Grande 1,885 miles 3,033 Km. — Colorada
SOUTH AMERICA	— Amazon 4,000 miles 6,437 km.
AFRICA	— Nile 4,145 miles 6,670 Km. longest river of the world. — Zambezi 1,700 miles 2,735 Km.
EUROPE	— Volga 2,194 miles 3,531 Km. — Danube 1,776 miles 2,858 Km. — Rhine 820 miles 1,319 Km.
CHINA	— Chang Jiang (Yangtze) 3,915 miles 6,300 Km. — Huang He
MIDDLE EAST	— Tigris, Euphratis
INDIAN SUB-CONTINENT	— Ganes 1,560 miles 2,510 Km — Indus, Brahmaputra, Irawati.

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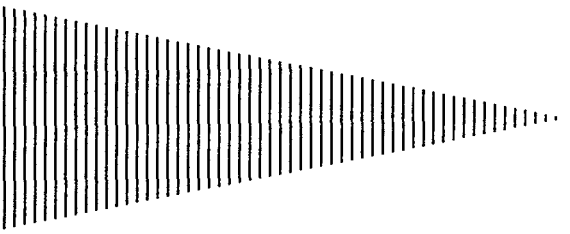
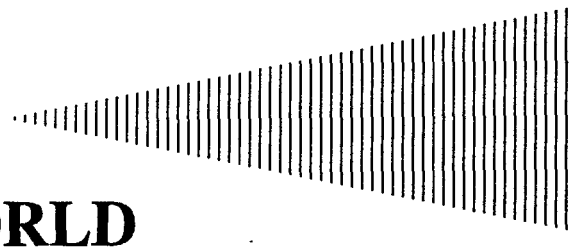


CHAPTER 11



CLIMATES AROUND THE WORLD

Our world has a great variety of climates, according to its regions. Typical weather condition and a temperature in a particular area, is called the climate. Similar types of climates are found in a different areas around the world. The climate of a particular place depends mainly on three aspects —

(1) Distance from the equator to the North and South latitudes, that means even poles, the way the Sunrays reach to these regions

(2) Distance from seacoast to interior.

(3) Distance of height above sea level that means altitude.

The regions around the equator are the hottest one in the world. The further away from the equator, the colder the climates become. The sunrays are directly overhead on the equatorial region while as they are at North and South region, they are not directly overhead, on the contrary, they have to cut most distance to reach the earth surface and while travelling this distance they have to travel through Earth's atmosphere and naturally they loose some of their heat and light and they become mild — weaker and weaker. Thus at the equatorial region Sun rays shine directly overhead and are much concentrated, and the land here, receives a lot of energy to heat the land. According to North and South latitudes, Sun rays become weaker and weaker and at polar regions they are very very weak, again as per North and South latitudes they have to cross more and more distance through Earth's atmosphere and because they meet Earth's surface at low angle, they loose heat on the way, becoming colder. Hence Polar regions are the coldest places in the world.

The climate is also affected by how close the place is to the sea. Sea warms and cools the land near it, so the coastal areas usually have fewer extremes of temperatures,

while the lands of interior regions have always extremes of temperatures as compared with coastal lands.

Another important influence is the altitude — how high the place is above sea level. The higher the place, the colder is the climate. That is why hill stations are always colder depending upon their height from sea level and also the latitudes. The layers of the atmosphere are like blankets on a bed. If one lies under a number of blankets, he will feel heavy. Similarly the large mass of air in the atmosphere is very heavy and pressure is the highest but as one goes higher and higher the air presses down hard on Earth, which is called air pressure. On the sea level this air pressure becomes less and less and thus at highest level the climate becomes very cold – ice cool – that is why highest mountains are always covered with snow and ice. Same is the case at highest level of atmosphere the ionosphere, where there is very little, almost negligible air pressure and hence above this level there is no distinction between atmosphere and space.

While watching the various climates in different parts of the world, we find that people of different regions have different types of appearance – the skin colour, the height, colour of eyes and hair, mostly these things depend on the climate and geographical conditions of the regions as well as the races.

● THE VARIOUS CLIMATES AS PER THE VARIOUS REGIONS

The Polar Regions

Both North and South Polar regions are too far from the equator. Again within these regions, the Sun continues to be overhead for six months and then for next six months, it does not rise at all. During the whole of six months summer, there is a long day of six months and during the whole of six months' winter, there is a long night of six months. Both the Polar regions are unique. On the South Polar region — that is Antarctica continent (because of its extreme coldness) which is thickly covered by ice sheets and temperature is below 128.6° F (89.2°C) nobody can live there, except the animals like Penguin and Seals. At the North Polar region, which is known as Arctic circle the climate is too cold here also, even then though scarcely people do mange to live herein in extreme difficult and harsh climate.

The Antarctic Circle

The South Polar region — It has the coldest and harshest climate in the world. Throughout the continent there is such a thick layer of ice that we can't see even a point of land, every where we see the ice and ice only. This layer is about 6,562 ft. thick and the ocean is also frozen and there are number of Icebergs, and the

temperature here is minus (below) 128.6° F. In Antarctica animals like Penguin and seals only can live and depend for their food on sea food only. No human being can live there permanently. The scientists from all over the world have base camps there for their research work, and that too for a certain period, which is also too cold, but in winter the scientists have to shift elsewhere as the human being can't survive there.

The Arctic Circle

North Polar region — It contains the North most part of North America — Canada, Europe, Russia (Asia) and most part of the island of Greenland and other tiny islands.

In the Arctic circle, the Arctic ocean is permanently frozen , and no land is there beneath the ocean. Inspite of a very difficult and harsh climate, there is a vast variety of animals and plants and people also live here though scarcely in a very diverse conditions, that means very difficult and harsh climate. The main human here are Intuit (Eskimos) and the Sami (Lapps). It is the most difficult, to have a life there but these people are managing anyhow. There is always 6 months day and 6 months nights, the whole of the Arctic circle is very wonderful and peculiar.

Tundra

"At the south of the North pole, in Arctic circle, lie the regions known as Tundra where the lower parts of land is permanently frozen and only mosses and lichens can grow. These regions sometimes are described as "Cold Deserts" as the climate is very dry also".

Taiga

"Then there is Taiga region, Taiga means cold forest. It's a Russian word. This is the huge area of evergreens forests that stretches across the Northern parts of Canada, Scandinavia and former U.S.S.R. but now we can say Siberia — Along with forest some types of vegetation can survive in this snowy climate".

Temperate Zones

"Much of the Northern Europe and parts of North America lie under this region and have temperate climate, which means that the temperature here is never too hot nor too cold, it is always normal, not extremes. It is because these regions have rainfall throughout the year though not heavy. They were once covered by forests though most of them have been cut down now. Deciduous trees which shed their leaves in winter are common in the temperate zones."

Tropical Zones

"The tropical zones are the equatorial regions, that means the regions around the equator. These regions are the hottest ones in the world, as the Sun rays are receive directly overhead on the sea regions, they are much concentrated, and the land here receives a lot of energy and heat. There is a great heavy rainfall throughout the year on these regions, and because of this, land consists of big dense forests and the area is always wet and green. Even though the tropical regions are the hottest one in the world, the wonderful thing is that the little area which comes exactly on the equator region is somewhat cooler than the other tropical area. It is because, on this area the heavy rain falls 24 hours throughout the year, because of the high temperature recycling of water of the sea goes on continuously. And because of this rain, the area which comes very near to equator happens to be cooler than the other tropical regions. Amazon rivers basin in South America is a very good example. Vegetable grow here very nicely."

Tropical Grassland

"The regions of tropical grassland such as the Africa savannah lie between the wet equatorial rain forests and the hot dry deserts. Here the climate is always hot but there are dry and wet two seasons in the year. Tall grasses, low trees and bushes grow here and naturally these areas are grazed by large herds of plant eating animals."

The Dry Grassland

"These are huge plains of grasslands in the middle of the continents. These grassland are the American Prearíers, the Russian steppe, and the Argentinean pampas. These regions have extreme climates, very hot summers and very cold winters, large parts of these have now been used for farming for growing wheat or raising cattles."

Hot Deserts

"The Hottest and Dryest climates are found in the tropical deserts, such as the Sahara in Africa, the Australian outback, the temperature there often reaches to 100° F (38° C) in the shade. In some desert areas, there may be no rains for several years. Deserts often contain sandy soil that can support plants like cacti which are adapted to the dry conditions."

Mountain Regions

"The temperature in mountainous region varies a lot, the higher up we go, the temperature becomes colder. Trees and plants grow only on the lower slopes of mountains, and above a certain height temperatures are too low for vegitation to

survive. Above this, there is the snow line and then it is so cold that the ground is permanently covered by snow and ice and nothing can grow there".

Mediterranean

"The "name Mediterranean" is given to the type of climate, which is found around the Mediterranean sea and in similar regions of the world such as California in North America. These regions have hot dry summers and cold wet winters. The trees and plants that grow there are specially adapted to survive the lack of water in summer"

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Note: All the contents in the inverted comas herein, are from the Atlas book "Rand Mc. Nally Picture Atlas of the World" Illustrated by Brain Delf.

CHAPTER 12

SOME NATURAL WONDERS OF THE WORLD

● AURORAS — BOREALIS AND AUSTRALIS

The night skies with stars and planets and occasional streak of a meteor or a tail of a comet is common but in northern and southern most parts a different celestial experience is common place.

The weather in the Sun's atmosphere is very different from that on Earth. Magnetic storms and explosions, that means flares blow up without warning on the solar surface and the electrical energy is released. The Earth is affected by the Solar storms, the Sun's flares blast electric particles into space, which have wonderful effects on Earth's atmosphere.

If clouds of electric particles from Solar flares reach the Earth, they create marvellous curtains of shimmering light in the sky, seen in polar regions, known as Aurora. It is unpredictable and therefore difficult to observe. It can take various beautiful and marvellous forms of arcs, rays curtains of light in the sky and there are never two similar display. It is essential a moonless night to be there to see these Borealis and austrilis aurora and it can be seen very easily in far northern and far southern latitudes, that means the polar regions. The dancing light of the aurora is amazing and such a beautiful sight that people of polar regions are always longing and waiting to see them.

● A FALLING STAR OR SHOOTING STAR AND METEOR SHOWER

For thousands of years man was wondering, while looking at "Falling Stars" and could not imagine and know, what are they and from where they come?

Today, we know that really speaking, they are not "Stars" at all. They are small solid bodies which travel through space and can also pass through Earth's atmosphere. Actually they are meteors. Some times meteor may travel singly and mostly meteors occur in swarms of thousands.

When a single, meteor enters the earth's atmosphere, it is called "falling star" or "shooting star." It enters with so high speed, that because of the great friction, it grows red hot, and the meteor gets burned and a sparking light is seen for a moment and we feel as if a star is falling. Same is the case of meteors, when they enter the earth's atmosphere in a swarm of thousands, they become fiery hot due to the friction with layers of the earth's atmosphere and we see a 'meteoric shower'.

Astronomers now believe that the periodic swarms of meteors are the broken fragments of comets. When comets breakup the millions of fragments continue to move through space as a meteor swarm or stream.

● RAINBOW

A *Rainbow* is one of the most beautiful sights in nature. It could be seen only during showers when rain is falling and Sun is shining at the same time. One should have to be in the middle, the Sun behind and the rain infront of ones body, then only one can see a rainbow, not otherwise. The Sun, the eyes of a person and the centre of the arc of the rainbow must all be in straight line.

Why is it so? It is because, the Sunlight or ordinary white light is a mixture of all the colours. We have seen many times that, when light strikes a soap bubble, the white light is broken up into different colours viz. red, orange, yellow, green, blue, indigo and violet.

An object that can break up light in this way is called "a prism". The colours that emerge, from a band of stripes, each colour grading into the one, next to it. This band is called "a spectrum". A rainbow is simply a great curved spectrum or a band colours caused by the breaking up of light, which passed through raindrops.

If the Sun is too high in the sky, its impossible to have such a straight line that we need and so, the rainbows are seen only in the early mornings or late afternoons. A morning rainbow means the Sun is shining in the east and showers are falling in the West. An afternoon rainbow means vice-versa.

● THE METEOR CRATER OF ARIZONA

The meteor is the visible trail in the sky, which is left by an object that gets burned up as it enters the atmosphere. These trails are also called shooting stars. A meteoroid

that reaches the ground without getting burnt completely is called meteorite and are often named after the place where they fall. Sometimes they are very small, but large meteorites like that of Arizona have made substantial craters. The Meteor crater of Arizona is 50,000 years old and has been best preserved because of the dry desert climate, and has prevented it from erosion and weathering. The same type of Meteor crater is also there in our India, at Lonar in Maharashtra, and is also 50,000 years old. It has now become lake, and is known as Lonar Sarovar.

● MIRAGE

Mirage could be said as a type of illusion of eye sight. Actually speaking, its a nature's trick. Nature plays this game of trick with three/four factors, viz. Man's eye, hot afternoon with bright light rays very very long distance upto horizon.

When all these factors are there together, a person concerned becomes a victim of mirage. When a person is travelling in desert or even through a very hot region, which has tar road, and all conditions given above happen to be there, the person concerned is naturally very thirsty and he sees a lake or pond at a very long distance and he becomes happy to see the water and runs after that like anything. He stumbles forward until the vision fades and there is nothing but the hot road or hot sand around him.

The lake, the person sees is nothing but a mirage. We know that we are able to see an object because rays of light are reflected from it (an object) to our eyes. Usually these rays reach our eyes in straight line so if we look off into the distance we would only see things that are above horizon.

Now we come to the tricks the atmosphere plays with rays of light. In a desert, there is a layer of dense air above the ground which acts as a mirror. An object may be out of sight, way below the horizon. But when rays of light from it hit this layer of dense air, they are reflected to our eyes and we see the object as if it were above the horizon and in our sight. We are really "seeing" objects which our eyes cannot see! When the distant sky is reflected by this "mirror" of air, it sometimes looks like a lake, and we have a mirage.

On a hot day, as you approach the top of a hill, you may think the road ahead is wet. This is a mirage too! What you are seeing, is light from the sky that has been bent by the hot air just above the pavement so that it seems to come from the road itself.

Ayers Rock

It is in the heart of desert in Central Australia. Nothing grows on its steep sides. And it is wonderful that the vast mass of Ayers Rock rises abruptly from the flat plains. The rock glows Red during sunrise and sunset.

Earthquake

Sudden violent movements under the surface of the earth is called earthquake. It is the shivering of the Earth's surface. Over many years, the plates slide past each other slowly, but sometimes the rocks get struck together and intense heat is formed inside the Earth which make the ground shake for a few seconds and is called earthquake. It makes a part of the surface concerned to move backward and forward or up and down, in short in all directions. These are the vibrations around the area. When it is with great force and intensity, the ground shakes very hard and earthquake is very severe, and causes wide spread destruction of all kind. Sometimes it changes the whole picture of the area. The earthquake areas are called earthquake zones.

Volcano

Suddenly a fountain of fire bursts out of the Earth's surface, showering with hot liquid rocks and clouds of dust and gases, as if the Earth is spitting fire. This is the eruption of volcanoes. Strong pressure underground, forces the magma through the cracks of the crust and when the magma bursts out a volcano erupts. The gases from the magma become the part of the atmosphere and liquid called Lava flows over the ground. Volcanoes are most found in the Andes range of South America and mountains in Japan, they are also found in some other places. Mt. Fuji (12,188 ft.) is the best example.

California

The central valley of California lies on the San Andreas fault, where two parts of the Earth's crust are slowly moving in different directions and this movement causes frequent earthquakes.

Geysers

(1) In Andes in South America at the Chile region, hot stream hisses into the cold air 13150 ft above sea level. There is natural hot steam underground.

(2) New Zealand — North Island

There are hot springs, boiling mud pools and volcanoes also, in the region around Rotorua on North Island. Hot water bubbles out of the ground in some places where, there is such pressure that water is forced out in a jet called geyser, reaching heights upto 230 ft.

● THE GRAND CANYON OF ARIZONA

Sometimes in the highlands and mountains region, there are some large rivers, which flow very fast and they always carry loose stones with them, and its wonderful that over millions of years they erode a passage through solid rocks, having great friction with force of water and the loose rocks and they make huge valleys out of this action, and these valleys are called Canyons. Colorado river has cut a huge canyon 150 km. deep and 600 km. long in the Arizona state in U.S.A. The Mountains slowly rise while the river kept digging its valley deeper.

● THE GREAT RIFT VALLEY OF EAST AFRICA

It is the largest crack in the Earth's crust, stretching 5,400 miles (8,700 km) from Syria in the North through Red Sea to Egypt and Mozambique in southern Africa, but actually it lies in the East Africa. The scenery of the Rift valley is most spectacular and the wild life here is also very attractive. In Kenya the walls of the valley rise almost straight up for 4,000 ft. 1,250 m.) The valley is a great tourists attraction. The peaks of Kenya and Kilimanjaro are snow-caped throughout the year. There are many lakes and sources of rivers in the valley.

Mount Everest

The mighty and highest Mount Everest crowns the Himalayas.

About 60 million years ago, India which was a separate continent at the time, began to move rapidly northward, eventually colliding with Asia. The push crushed the land on the continental shores into what is now the highest mountain range in the world — "The Himalayas", which means "abode of snow", in Sanskrit.

The entire range of magnificent snow-covered peaks is a natural wonder. It makes its name Himalayas in real sense. Shrouded in mystery due to its height, remote location and restrictions on access by Chinese and Nepalese, Everest has been the dream of climbers.

New Zealander Edmund Hillary and Sherpa Tenzing Norgay reached the peak, and there was a first record to capture the Everest by men, against nature's most difficult and struggling task. They had to march over the frozen ridges and stand on the highest point in the world. Since then much more attempts have been made to reach its top — using different routes. Thousands have made attempt to capture Mount Everest. But about 700 have succeeded while atleast 150 others have died trying. They had lost their lives. Only brave mountaineers are attracted to capture Himalayan Peaks, one is not sure whether he will be able to return back. The mountaineers have to take much training before entering the venture.

● THE LONGEST RANGE OF MOUNTAINS, UNDERWATER —

Friends, do you know that, the longest range of mountains in the world, is underwater. It stretches from East Africa, through the Indian Ocean, around the Southern Australia and across the Pacific Ocean to the Gulf of California, having a distance of 19,200 miles (300,900 km) such a long distance!

The Dunes: Dunes could be said as the mountain of the deserts. Sometimes in desert also there are very strong winds that carry the sand in certain direction at certain place with great force, and a triangular shape sand collection is made. This wind blown sand is called Dune. In Sahara in Northern Africa there is vast seas of sand which form dunes above 600 ft. high. Oasis is a fertile area, even in desert where palm trees grow, because there is underground water which feeds the palm trees as well as travellers.

● THE CAVES

Caves have been linked with the history of mankind. Late in Old Stone Age, man was using the caves in winter as their homes, people at the time, had no other alternative for shelter. But long after man stopped using caves as homes. Ancient people believed strange ideas about caves.

Caves are deep hollow places in the rocky sides of hills of cliffs. Large caves are called "Caverns". Today, huge and beautiful caves all over the world have become tourist attraction.

Really speaking caves are the lands, beneath the landscapes, and are formed in different ways, one of the natural wonders ! They appear under the surface of the Earth. And are usually the old courses of underground streams which have worn away layers of soft rock such as limestone. The most common type of caves are that made by the wearing away of thick layers of limestone, which is done by action of water containing carbon dioxide. Some times caves have been hollowed out by the constant beating of the sea waves against the rocks. Some others are formed by the volcanic shifting of surface rocks or by eruption of hot lava.

● THE RIVERS - AMEZON AND CONGO BASINS - EQUATORIAL RAIN FOREST REGION

"Around the equator of the Earth lies a band of tropical forest. Here it rains almost every day and the Sun is constantly overhead, conditions are hot and sticky and stiflingly humid. It is much like a greenhouse. And just as in a green house the plants can grow luxuriantly. Tall trees upto 330 ft. (100 m.) in height, reach up towards the sunlight, spreading their branches and leaves to the sky. They grow so closely that

their boughs overlap producing an almost continuous canopy of greenery far above the ground.

Beneath the canopy it is dark and gloomy. Because the topmost branches and leaves are so close together that very little light filters through. Bushes, shrubs, and undergrowth can grow, only where the light reaches the lower levels. This may happen along river banks or where the big tree has died and fallen, leaving a gap in the canopy. When such gaps appear, they do not last long. New trees germinate, before long a tree has grown to replace the lost giant tree. Again the forest floor is plunged into dim misty twilight.

Animal life in the tropical forests is very varied. Much of it lives in the treetop canopy, Monkeys and Apes swing on the branches. Butterflies flutter around the many glorious flowers. Birds of prey swoop and wheel boughs and trunks, dropping on unwary lizards and squirrels. Snakes lie in wait along the creepers camouflaged among the greenery. On the thick forest floor, pigs and other compactly shaped animals live. They dart off between the massive trunks whenever danger threatens.

The constant heat and moisture helps the plants to grow so thickly. The temperature is 75°-90° F. The Sun is almost always overhead and there are no seasons. The moisture is the result of prevailing wind system which brings 80 inches (200 centimetres) of rain. The rain is evenly distributed throughout the year.

Where the Sun shines constantly heating the ground, the air above the ground also heats up. This hot air, being lighter than cool air rises. Cooler air then flows into take its place. This gives rise to a constant flow of wind toward the equator. These winds do not blow due north and due south, but are deflected to the west by the rotation of the Earth. The resulting winds are the northeast trade winds and the southeast trade winds. Because these mostly blow over the ocean, they bring moisture to the equatorial regions. Then, when the air carried by them is heated and rises over the equator, the moisture carried condenses into clouds and falls as rain. The tropical rain forests result". The whole topic is an extract taken from the book – "Secrets of the Earth" by Dougal Dixon.

● THE RIVER AMAZON — SOUTH AMERICA

Friends, river Amazon may not be the longest river in the world, the river Nile being number one in the length, but Amazon is the mighty river, we can say it's a biggest river in the world. It's a second longest in the world and is 4,000 miles (16,437 km.) long. At many points it is too wide for a person on one bank to see the opposite shore. It drains a vast areas of land including Amazon rain-forest. Really speaking the

Amazon is the flowing giant that carries more water than the Mississippi, Nile and Yangtze – rivers put together.

Friends, it's wonderful! Is it not? The river Amazon'a source is in Andes, in Peru region, at source it is small one as all the rivers are usually. But during its travel from its source to its mouth, a number of big rivers join it. At its mouth also it is about 1 mile wide and it splits in various streams and joins Atlantic Ocean on the east coast. So, now you came to know why it is called the mighty river?

The River Congo — South Africa

Being the rain forest region on equatorial region, the basin of Congo is nearly similar to Amazon. It is a big river and some other rivers join it but it can't be compared with the mightiness of the Amazon.

● WORLD'S MIGHTY AND IMPORTANT FALLS –

The Angel Falls

In Venezuela in South America it is the world's highest fall. It has a total height of 3,212 ft. (9179 meters). It's longest unbroken drop is 2,648 ft. (807 meters – river Orinoco)

Victoria Falls

Many water falls are dramatic, but Victoria falls in Southern Africa is one of the most thrilling sights, in the world. The Zambezi river about 1 mile (1.6 km) wide at the falls, drops suddenly into a deep narrow chasm. In the centre of the falls the river drops 355 ft. (108 meters into the gorge).

Niagara Falls

Niagara falls is one of the most spectacular natural wonders of North America. At the falls the Niagara river, which forms part of the united states and Canada border, plunges into a deep gorge. Niagara falls is actually two water falls – the Horseshoe falls which is in Canada and the American Falls which is in the United States.

The Horseshore falls is about 167 ft. (51 meters) high and 2,600 feet (792 meters) wide at its widest point. American Fall is about 176 feet (54 meters) high and 1,000 feet (305 meters) wide. It has a demarcation line in gorge water also.

It occupies such a vast area that one cannot see it at a glance – can't cover the whole sight of Niagara at a time. Because of the vastness of the falls, one has to see it from various points at different lands to cover the entire view of Niagara. The water

falls or leaps down in such a great force and roaring noise, that the sight becomes very beautiful, at he same time awesome and mysterious.

Below the falls people can travel in steamers close to the churning waters and can get soaked and enjoy it very much. It's a really a wonderful and awesome experience one can have.

● THE GREAT BARRIER REEF

Australia

It is a maze of about 2500 coral reefs and islands stretching 1,200 miles (2000km.) along the warm sea of the coast of Queens Land. It contains over three hundred species of coral and thousands of fish. Coral is formed by million of tiny sea animals called polyps, which cement themselves together. The reef is slowly being eaten by creatures called crown of thorns starfishes. In order to protect it, Marine Park has been formed.

The Fjords

Norway is mountainous and the country's coastline is dotted with long narrow bays called fjords. During the last great ice age, huge ice sheets glaciers formed over Scandinavia. The moving ice carved out deep steep-sided valleys, when the ice sheets began to melt about 11,000 years ago. Many of these valleys were filled by the sea, forming the famous Norwegian fjords.

Gulf Stream

Friends, do you know a wonderful thing, that there are some streams, flowing like a river under the water through the oceans ? Yes, there are some currents warm while some are cold. And they make wonderful effects on the climates of the countries near which they flow, warm or cool as the currents are. And Gulf Stream is the most famous warm Ocean current. It is so vast that it is larger than all the rivers of the world put together.

The water of the Gulf Stream comes from the movement of the surface waters near the Equator in the Atlantic. Thus the Gulf stream starts by moving from north of South America and into the Carribean Sea. But even if it is so, it actually gets its name "Gulf Stream" when it starts moving Northward along the east coast of the United States. As it starts at the Equator, the hot part of the world, it is a current of warm water. And the presence of this huge current of warm water makes wonderful differences in the climates of many places.

Then the Gulf Stream moves towards north across the north Atlantic and flows through English channel and again northward to the Coastal lines of European countries like Norway, Sweden, Denmark, Netherlands and Belgium. The winds that pass over the Gulf Stream are made warm and moist, hence all these countries enjoy warm winter that means the bitterness of the winter in far north becomes mild. London and Paris also enjoy mild winter climate, because of the presence of Gulf Stream.

As Gulf Stream makes great effects on European countries climates, it does not have much effect on North America, because the winter winds do not blow over it and then inland, as in European countries.

City on the Sea

Venice is the city with no highways and no roads. People go out by boats on the city canal. It covers about 120 tiny islands off the coast of Italy, at the north end of the Adriatic sea. It has more than 150 canals and they are inter linked.

Rotterdam

It lies in Netherlands on the banks of river Rhine where the river joins the North Sea. Rotterdam and Port Antwerp in Belgium are the Europe's biggest port. But Rotterdam is the biggest port in the whole world. Ships come from all over the world and barges travel along the river Rhine and the canals of Europe to reach the port.

Holy city of Middle East

Jerusalem is the holy city for three religions – Judaism, Christianity and Islam. People of all the three religions live there and pilgrims of the three religions and tourists visit the city. Millions of people visit the city every year. It is one of the ancient cities in the world.

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CHAPTER 13

SOME IMPORTANT THINGS

(1) How does jet lag affects one's body?

While flying abroad, the physical and mental stress encountered by airplane travelers, when crossing zones four or more times is commonly called jet lag.

Pattern of hungers, sleep and elimination along with alertness, memory and normal judgement may all be affected. More than 100 biological functions that fluctuate during the 24 hour cycle (circulation rhythm) can become desynchronized. Most people's bodies adjust at a rate of about the one hour per day. Thus after four time zone changes, the body will required about four days to return to its usual rhythms. Flying eastward is often more difficult than flying west ward which adds hours to the day.

(2) What is International Date Line?

It is an imaginary line fixed and drawn through the Pacific Ocean, from North to the South, where no land is there. When an airplane or ship crosses this line, people have to adjust their watches, and those who are traveling from America to Japan have to extend their watches for one day that means they have to go one day further and those are traveling in opposite direction that is from Japan to America, they have to adjust their watches back to 24 hours, means one day. As the Earth rotates itself, there would have been a chaos if this adjustment would not have been done. It is also necessary to have some fixed place, where this adjustment could be done. Again this line is drawn through pacific where no land is there. It is because, if it would have been on any land, they may have suffered the chaos and confusion and hence the International date line is drawn through Pacific Ocean to avoid all this. Being the largest ocean and having fewer land, it has become possible to get line without land from north to south.

Even then sometimes at some places the line has to change its direction for a while to avoid some tiny island.

Table

1 million	=	10,00,000	=	10 lacs
10 million	=	1,00,00,000	=	1 crore
1 Billion	=	1,00,00,00,000	=	100 crores

THE PLANETS DISTANCES FROM THE SUN

Name	*In Millions of Miles*	*Compared to Earth*	*Time to orbit the sun in years*	*Mass compared to the earth*	*Radiums compared to Earth*
Mercury	36	0.39	0.24	0.06	0.38
Venus	67	0.72	0.62	0.82	0.95
Earth	93	1.00	1.00	1.00	1.00
Mars	142	1.52	1.88	0.11	0.53
Jupiter	484	5.20	11.86	318.00	11.00
Saturn	887	9.54	29.46	95.00	9.00
Uranus	1783	19.18	84.00	15.00	4.00
Neptune	2794	30.06	165.00	17.00	4.00
Pluto	3706	39.44	248.00	0.0024	0.28–0.34

Longest Railways from one end to the other end of the nation —

(1) Trans Siberian Railway – Russia

It runs from Mosco to Vladiostostok and is 5.777 miles long. It takes a week to cross Russia by train and one has to change his watch time as per the train crosses the regions of longitude.

(2) The India Pacific Express – Australia

It runs from Perth to Sydney and is 2,700 miles long. It is called Indian Pacific Express because, Perth lies on the coast of Indian Ocean and Sydney on the coast of pacific ocean crossing the two ends west and east of Australia. It takes three days and three night to cross Australia by train.

(3) Trans Canada Railway – Canada

It runs from Montreal to Vancouver a distance of 2,852 miles. It runs since 100 years ago and has a diesel Engine and Silver coaches. It crosses a viaduct in the province of Ontario. It started running 100 years ago to Unite Canada as one country.

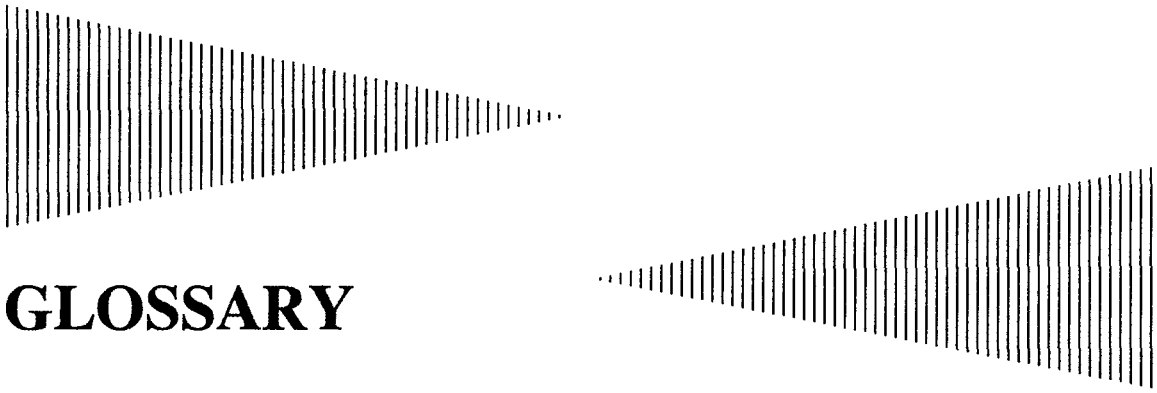
Friends, here ends our story of "Our Home Planet The Earth". How did you like it? It's a wonderful! Both the stories of "Our Solar System" and "Our Home Planet The Earth" are really wonderful and full of mysteries. Is it not?

O.K. then, bye dear ones,

Be happy and try to be somebody by studying more and more, because this is just a beginning, "ABC" of the subject!

Have a great success dear ones,

Yours loving,
Shamaaji



GLOSSARY

PART 1

Chapter 1: BIG BANG

1. **Colossal** — Huge, gigantic —
2. **Big Bang** — The cosmic explosion that marked the origin of the Universe according to the Big Bang theory.
3. **Big Bang Theory** — A cosmological theory that the universe originated billions of years ago from the violent eruption of point source.
4. **Explode** — To release mechanical, chemical or nuclear energy in an explosion, to burst violently from internal pressure. To burst forth without control, to cause to explode or violently and noisily.
5. **Atom** — The smallest unit of an element, made up of a dense, central, positively charged nucleus, surrounded by a system of electrons equal in number to the number of nuclear protons. The irreducible. The indestructive material unit of ancient atomism.
6. **Nucleus** — Central Part
7. **Proton** — A sub atomic particle, with a positive electric charge, found in the nuclei of atoms. A single proton forms the nucleus of a hydrogen atom.
8. **Electron** — A tiny subatomic particle with a negative electrical charge.
9. **Neutron** — A subatomic particle with no electric charge found, in the nuclei of atoms.

10. **Quarks** — Any of a group of hypothetical, subatomic particles having electrical charges of magnitude one-third or two-thirds that of the electron proposed as the fundamental units of matter.
11. **Gluons** — A massless neutral elementary particles held to mediate the strong interaction that binds quarks together.
12. **Clumps** — Cluster of, group of
13. **Universe** — Everything that exists, the space and its belongings.
14. **Astronomer** — One who studies astronomy.
15. **Interstellar** — Interstellar matter means the gas and dust in between the stars or celestial objects.
16. **Misty** — Mist — thin fog
17. **Nebulae** — (Pt. of Nebula) A cloud of gas and/or dust between the stars or around stars. Galaxies were called nebulae before they were known to be made of stars.

Chapter 2: INTERSTELLAR MATTER

1. **Billions** — One million millions;
2. **Immense** — Very large
3. **Maze** — Thin mist,
4. **Swirling** — (Swirl) — to eddy, to whirl
5. **Emit** — to give or send out
6. **Protostellar** — Proto — Earliest; first formed — in relation to star
7. **Protostar** — A star in a very early stage of formation.
8. **Nuclear** — Having to do with atomic energy;
9. **Nucleus** — Central part
10. **Molecule** — The smallest particle of an element or compound;
11. **Stellar** — Related to or consisting of stars

Chapter 3: GALAXY

1. **Spiral** — Winding round and round like a thread of a screw;
2. **Ovoid** — Egg shaped,
3. **Soot** — Black powder left inside a chimney, here it means, black powder spread out all over the interstellar matter;
4. **Fog** — Thick mist,

5. **Elliptical** — Having oval shape,
6. **Ellipse** — Oval shape;
7. **Cluster** — Punch, Group
8. **Enormous** — Vast
9. **Bulge** — To swell beyond its size,
10. **Black hole** — a region in space, where so much mass is concentrated, that its gravitational pull prevents even light from going out.
11. **Cluster** — Group & punch
12. **Ellipse** — Oval shape — Elliptical — Oval shaped

Chapter 4: STAR

1. **Asteroid** — A piece of rock and/or ice, orbiting the Sun like a tiny planet.
2. **Orbit** — The Path through space of a body, under the influence of the gravity of another object.
3. **Luminosity** — The amount of energy radiated per second by a glowing object.
4. **Light Year** — The distance travelled through empty space by light in one year — 9.5 million million km.
5. **Magnitude** — The brightness of a star or other astronomical object. The smaller the magnitude the brighter the object.
6. **Parsec** — A unit distance measurement used only by professional astronomers, equivalent to 3.2616 light years.
7. **Illuminating (Illuminate)** — To give light to;
8. **Spectral** — Of or like a spectre
9. **Spectre** — Ghost

Chapter 5: OUR SOLAR SYSTEM

1. **Asteroid Belt** — The belt which is in between the orbits of Mars and Jupiter, which consists small objects which are also called planet-simals, because they have properties like planets but are too small to be called planet, they are about 3000 numbers.
2. **Meteor, Meteorid and Meteorite** — A meteorid is a piece of rock or dust, out in space, Meteorids range in size from specks of dust to rocks weighing several kilo grams, and the Earth is constantly bombarded by them. They enter the atmosphere with such a great speed, that friction with air heats the particles until they get red-hot. A **meteor** is a visible trail in the sky, which is left by an

object that gets burned up as it enters the atmosphere. A Meteorid that passes through air and reaches the ground, is called Meteorite.

3. **Ecliptic** — The path of the Sun in the sky;
4. **Comet** — An icy object orbiting in the Solar System which evaporates gas and dust and grows a tail when it is near enough to Sun's light and heat
5. **Chaotically** — Chaos, complete disorder
6. **Accretion** — to increase , addition,
7. **Core** — Centre,
8. **Terrestrial** — Worldly — terra.
9. **Silicate** — One of a great number of compounds containing silica
10. **Eccentric** — Odd, whimsical
11. **Tug** — To pull hard,

Chapter 6: LITTLE HISTORY

1. **Enthusiasm** — Zeal
2. **Perfectuate** — To make complete

Chapter 7: THE SUN

1. **Shimmer** — To shine with wavering facing light,
2. **Engulf** — To swallow up
3. **Wriggle** — To move the body about the quick twists;
4. **Wisp** — Small bundle of straw;
5. **Prominence** — The state of being prominent;
6. **Incredible** — That cannot be believed;
7. **Ecliptic** — The Sun's yearly path around the sky as seen from the earth,

Chapter 8: MERCURY

1. **Resonance** — The quality or state of being resonant (Resonant — Resounding
2. **Sidereal time** — Time measured according to the rising and setting of the stars, rather than the Sun. Astronomers find it useful for planning observations.
3. **Crater** — Mouth of Volcano;
4. **Erosion** — The wearing away of rocks etc.,

Chapter 9: VENUS

1. **Retrograde** — Directed backwards, opposite side
2. **Synchronize** — To have the same timing;
3. **Greenhouse effect** — The heating of a planet's surface and atmosphere when heat radiation from the Sun gets trapped by the gases in the atmosphere.
4. **Mush** — Soft pulpy mass;
5. **Scorching** — That which is very hot, too hot;
6. **Swirl(ing)** — To eddy, to whirl;
7. **Blister(ing)** — Swelling of the skin —

Chapter 10: THE EARTH

1. **Radioactive** — Exhibiting or using radioactivity.
2. **Radioactive** — The spontaneous emission of radiation from atomic, nuclei —
3. **Radiation** — Sending out of heat etc. — in rays
4. **Decay** — To go bad;
5. **Drift** — To carried away by current
6. **Spectrum** — The band of colours into which a ray of light is broken up by a prism.
7. **Prism** — A block of glass that separates sunlight into colours
8. **Pefectuate** — To make eternal;
9. **Symbiotic:** (symbiosis) — A close association of two animal of plant species that are dependent on one another;

Chapter 11: THE EARTH'S MOON

1. **Hump** — It is that, when water rises very high;
2. **Seismic** — Of earthquake;
3. **Estuaries** — Estuary — firth,

Chapter 12: ECLIPSES OF THE SUN AND THE MOON

1. **Eclipse** — Cutting off of Sun's light by Moon or Moon's light by Earth.
2. **Spectacle** — Grand, very beautiful;
3. **Imminent** — likely to come or happen soon;

4. **Sparse** — Thinly scattered;

Chapter 13: MARS

1. **Stupendous** — Amazing, (in the size and degree;
2. **Cirrus** — Cloud high in the sky, delicate one

Chapter 14: JUPITER AND ITS MOON

1. **Sustain** — To maintain;
2. **Blaze** — bright flame of fire,
3. **Postulate** — To demand, to require, to claim;
4. **Bulges** — To swell beyond its size
5. **Turbulent** — Violet;
6. **Vicinity** — nearness;
7. **Whizzing** — Whizz — to make a hissing sound, like an arrow or ball fly through the air.
8. **inclination** — To have or cause to have a tendency

Chapter 15: SATURN AND ITS MOON

1. **Awesome** — Inspiring awe
2. **Awe** — Reverential fear,
3. **Incredible** — That cannot be believed
4. **Gale** — Strong wind
5. **Ancestry** — Ancestor —
6. **Haze** — Thin mist;
7. **Baffle** — To puzzle;
8. **Riddle** — Puzzling question;
9. **Boulders** — Large mass of stone or rock, rounded by water or weather;
10. **Soup** — To increase the power of;

Chapter 16: URANUS AND ITS MOON

1. **Bewilder** — To perplex, to confuse;
2. **Groove** — Channel or hollow;

3. **Cliff** — high, steep face of rock

Chapter 17: NEPTUNE AND ITS MOON

1. **Occultaim** — (Occult — secret;

Chapter 18: PLUTO AND CHARON

1. **Anomalies** — (Anomaly) — irregularity;
2. **Deviation** — (Deviate) — To turn aside; turning aside or away
3. **Apogee** — The farthest point on the Moons orbit from the Earth
4. **Perigee** — The closet point on the Moons orbit from the Earth
5. **Aphelion** — The point farthest from the Sun on the orbit or a celestial body, say planet and all others.
6. **Perihelion —** The point nearest the Sun, on the orbit of a celestial body, say planet and all others.

Chapter 19: ASTEROID AND METEORS

1. **Cataclysm** — deluge,
2. **Cruising** — (cruise) — to sell to and fro,
3. **Slam** — Violently;
4. **Nudge** — To push slightly (with elbow)
5. **Cosmic** — Of the universe;

Chapter 20: COMETS

1. **Relics** — Things surviving from the past;
2. **Gritty** — Grit small particle of stone, sand containing grit;
3. **Remnants** — Things surviving from the past;
4. **Blizzard** — heavy snow storm;
5. **Blast** — Strong gust (sphot)
6. **Riddle** — Puzzling question;
7. **Stray** — To roam, to move;
8. **Presage** — To foretell;
9. **Cataclysm** — deluge —

10. **Wobble** — To go unsteady;

PART 2

1. **Tectonic** — Functioning as singular
2. **Crumpled** — To crush together into creases;
3. **Wrenched** — sudden or painful twist or pull;
4. **Ridges** — Raised lines where two sloping surfaces meet;
5. **Epochs** — A point in time
6. **Delineation** — (Delineate) to portray, the act of delineating;
7. **Slam** — Violently;
8. **Crease** — Line made by folding;
9. **Momentum** — quantity of motion of a moving body.
10. **Sierra** — A range of mountains with jugged peaks ;
11. **Barges** — Flat bottomed freight boat —
12. **Radiograph** — An instrument for measuring the intensity of Sunshine.
13. **Radium** — Radio active element,
14. **Radioactive** — Exhibiting or using radioactivity —
15. **Radioactivity** — The spontaneous emission of radiation from atomic nuclei;
16. **Isotope** — An atom of an element having nuclear mass different from that of the other atoms of the same element although chemical identical;
17. **Radioactive isotope** — An isotope that is radioactive.
18. **Aweful** — dreaful;
19. **Permafrost** — A layer of permanently frozen soil
20. **Aurora** — Coloured glows in the Earth's atmosphere seen from time to time in the night sky over polar regions.

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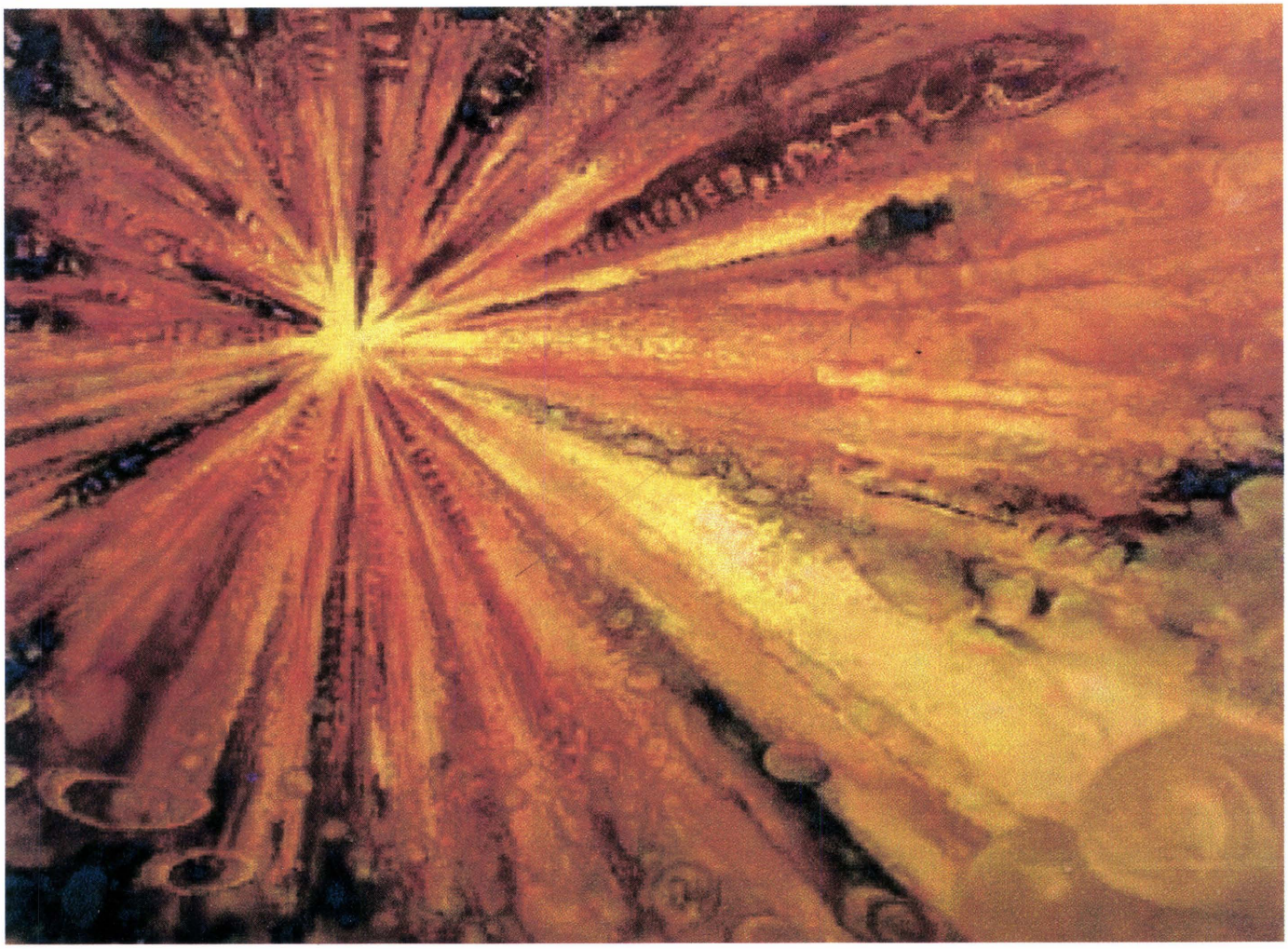
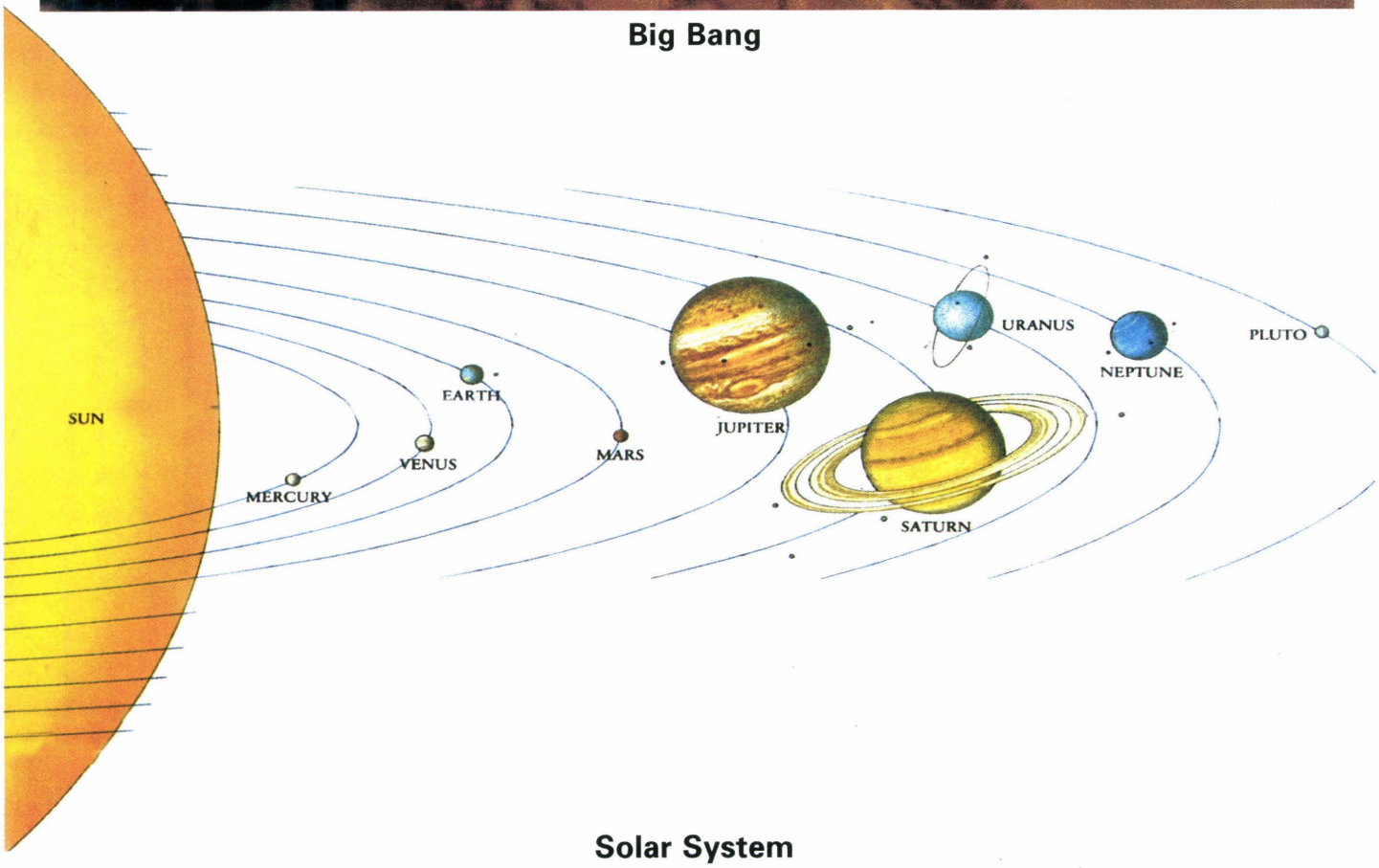
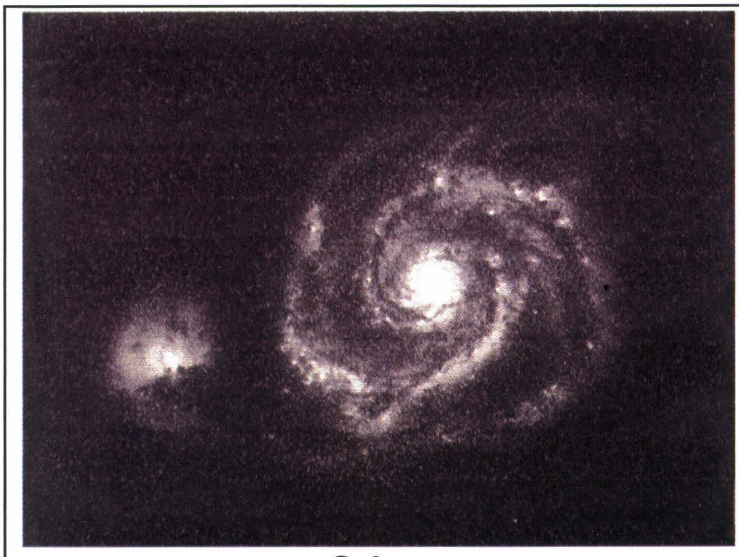


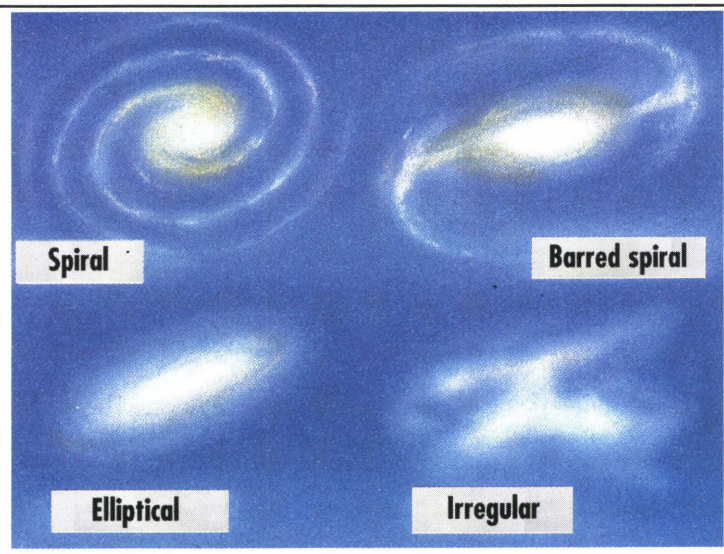
Big Bang



Solar System

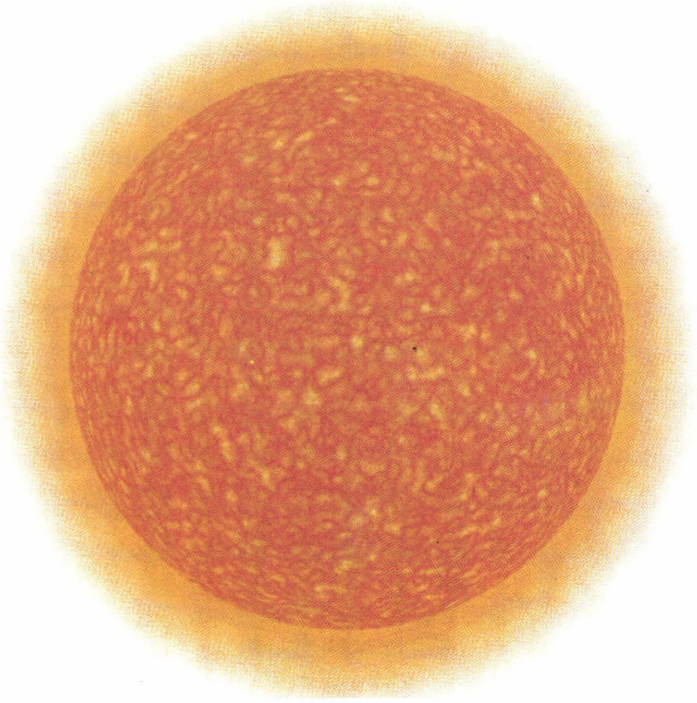


Galaxy

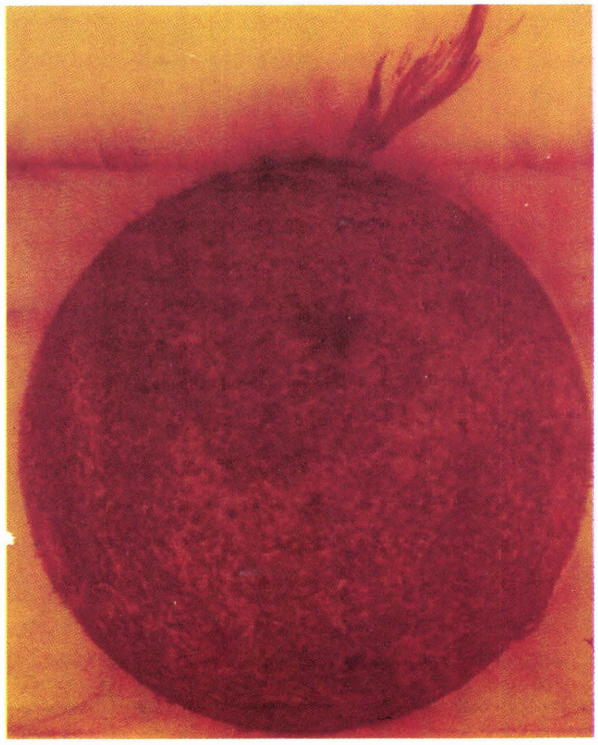


Galaxies

Nebula



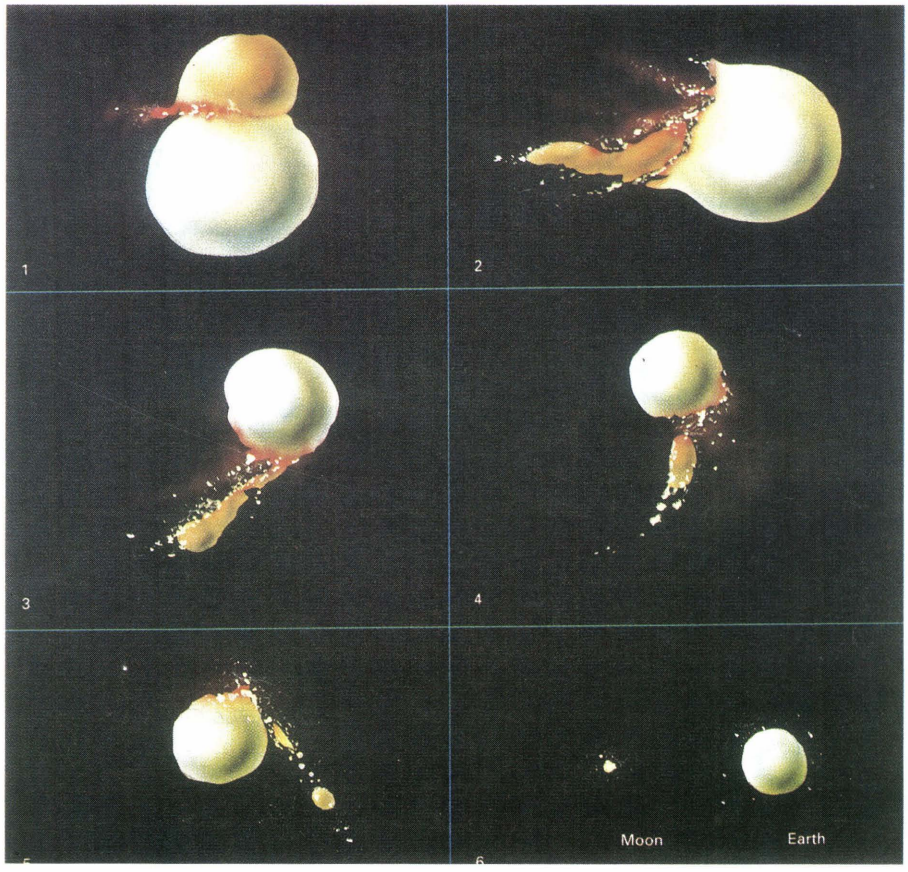
Photosphere of the sun



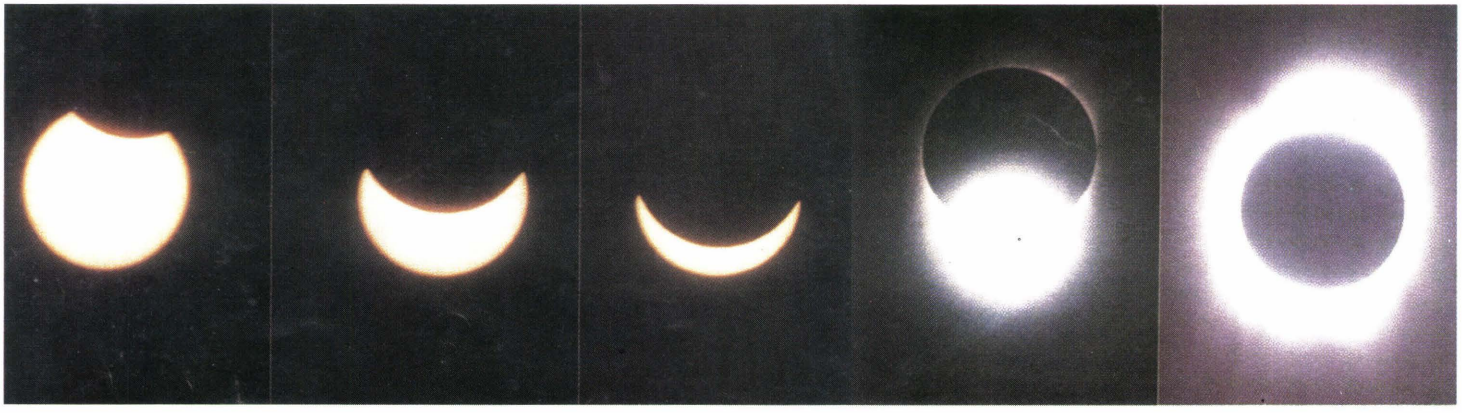
Solar Prominence of the Sun

The Planet Earth, as it looks from space

Earth's Moon

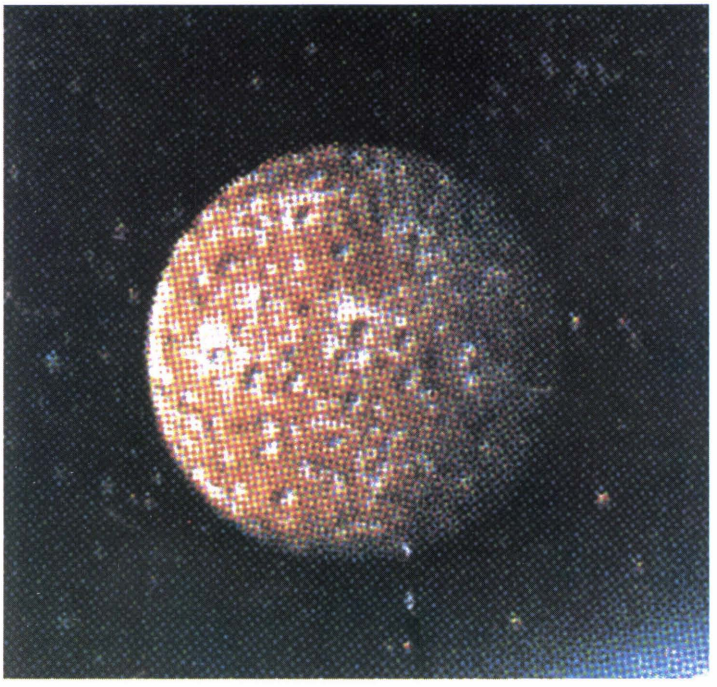


Origin of the Moon

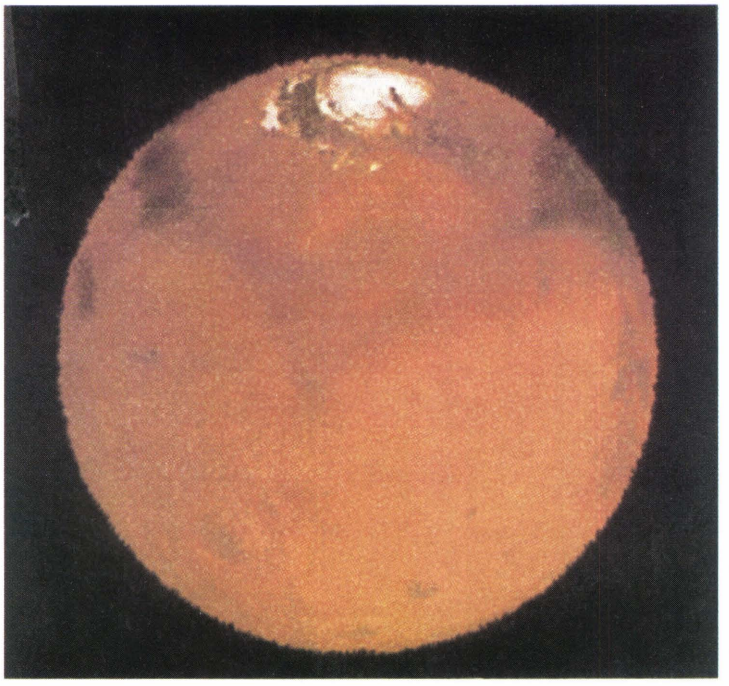


Eclipes of the Sun

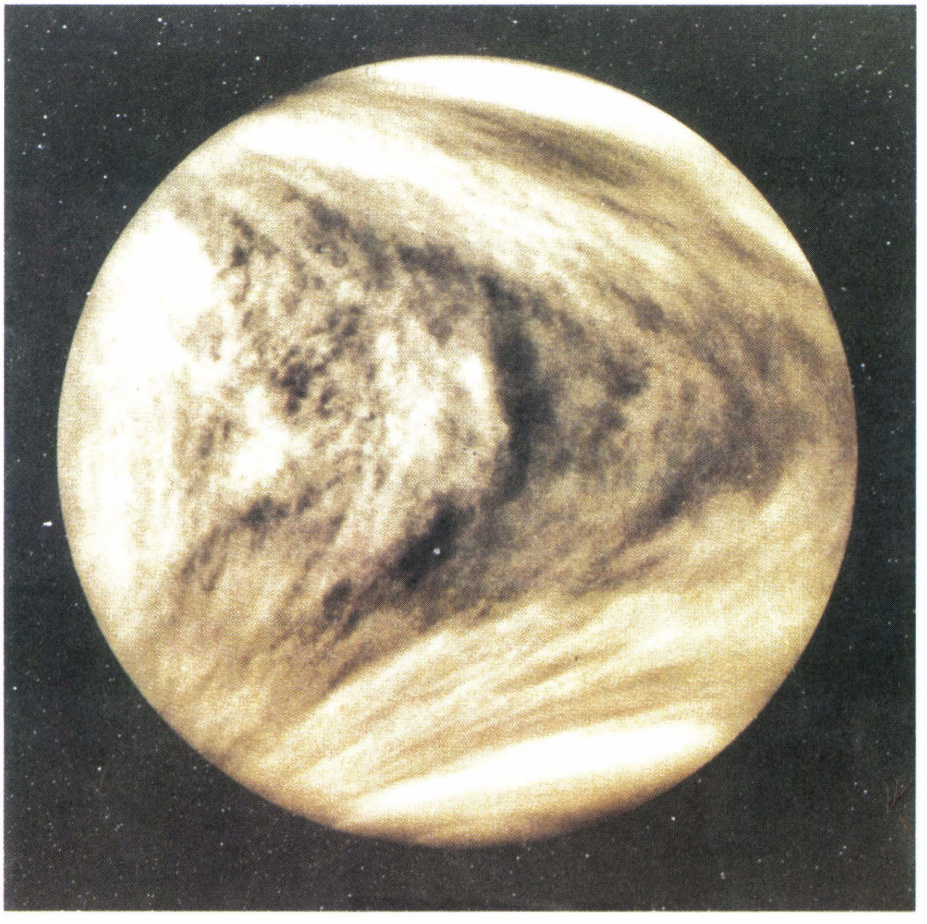
Eclipes of the Moon



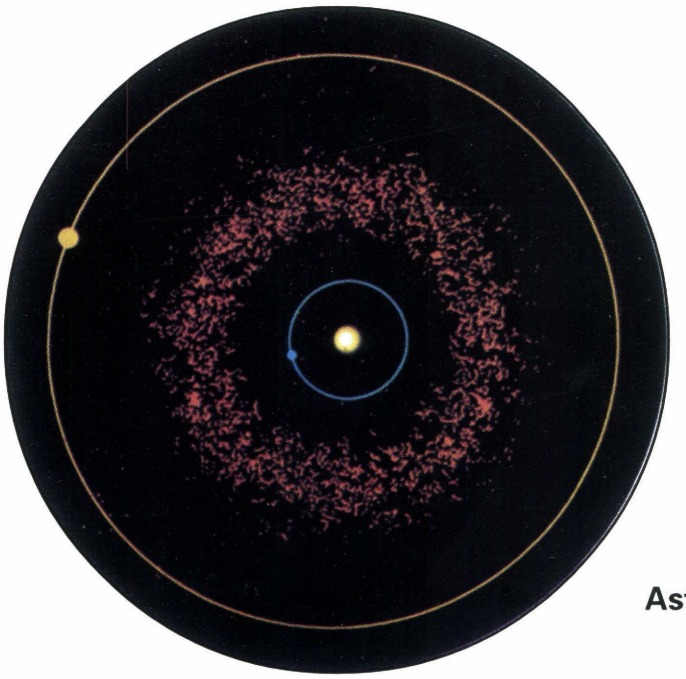
Planet Mercury



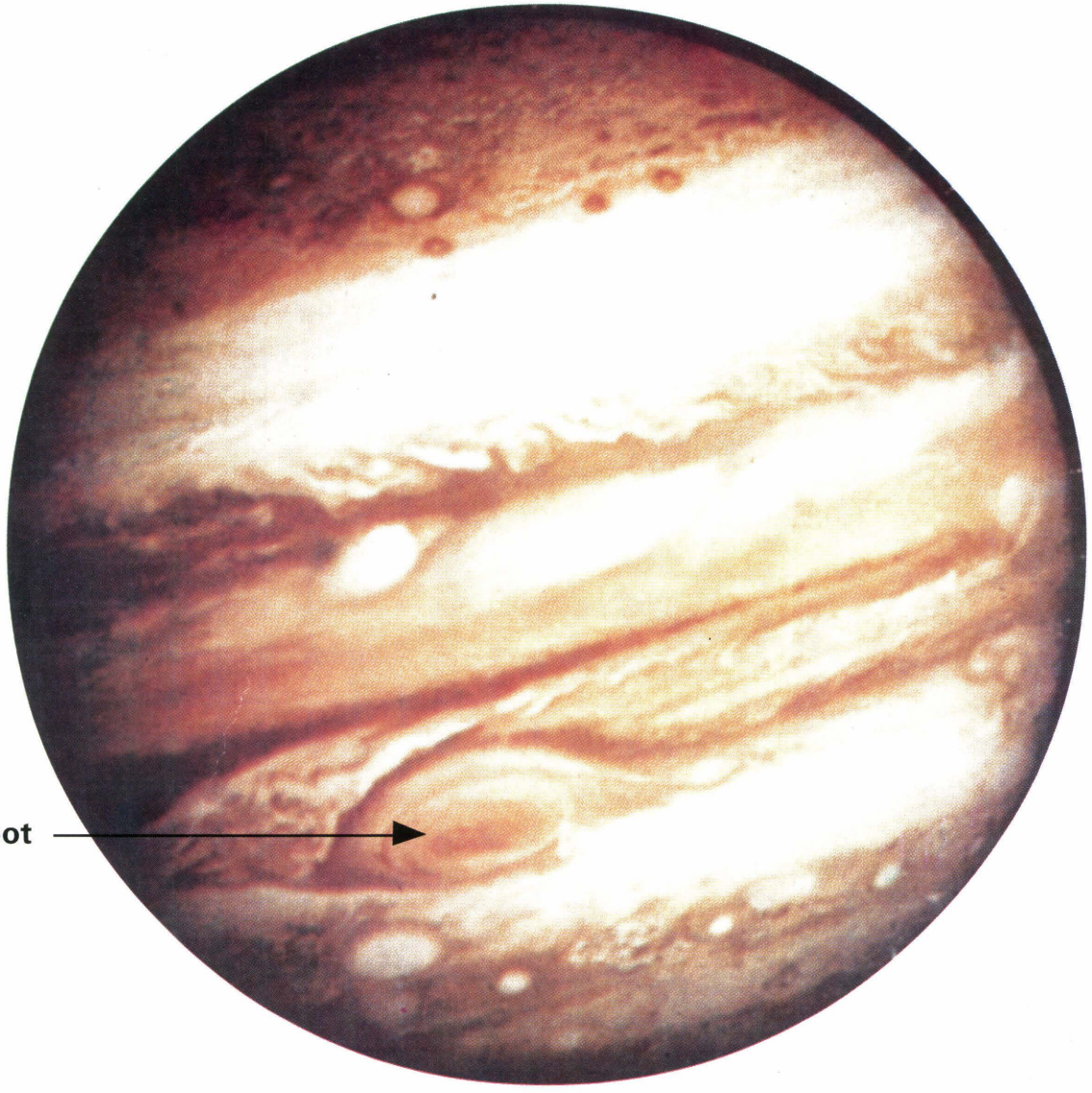
Planet Mars



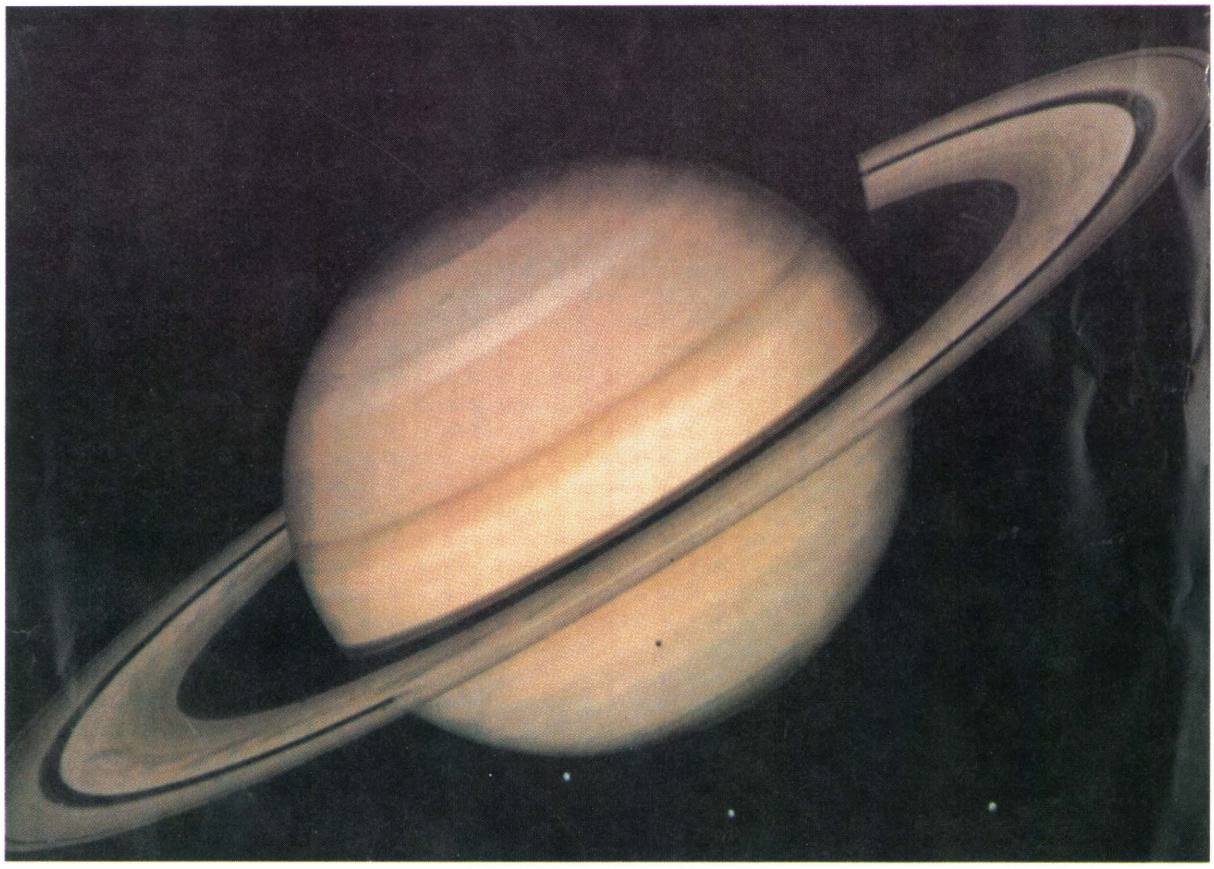
Planet Venus



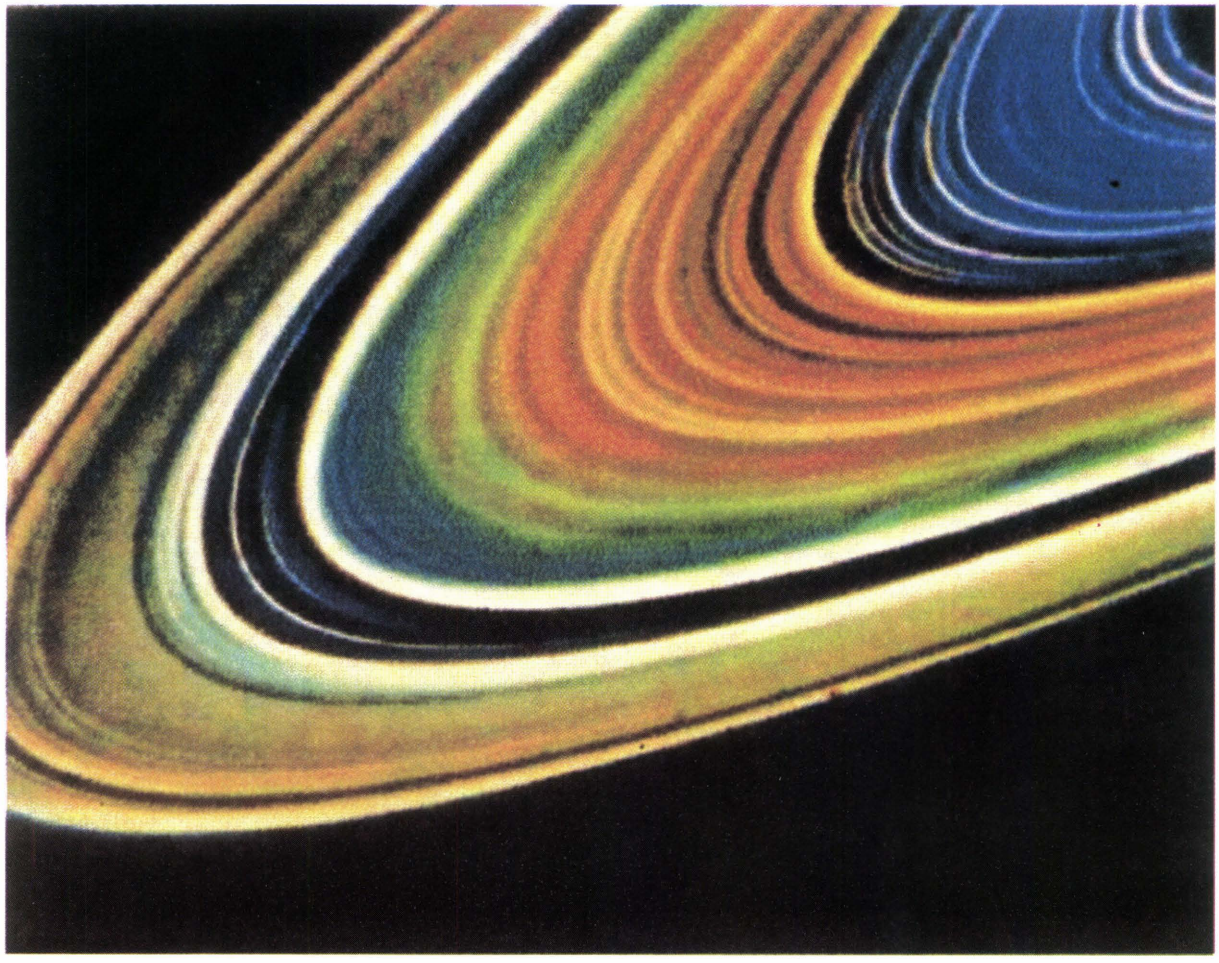
Asteroids Belt



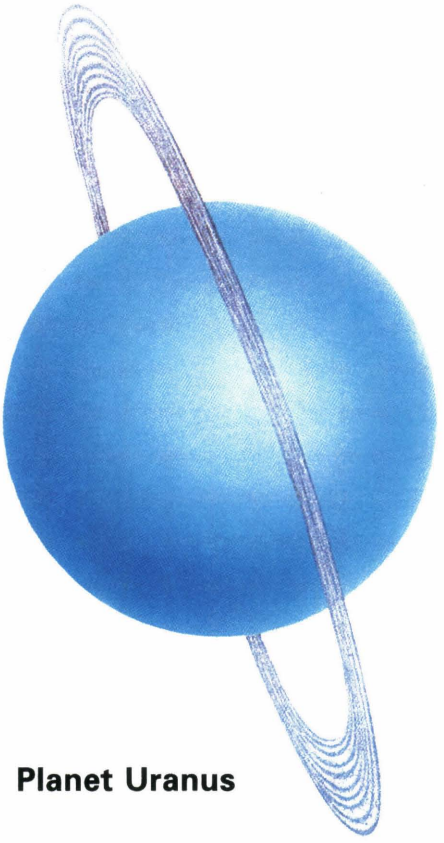
Jupiter with its Red Spot



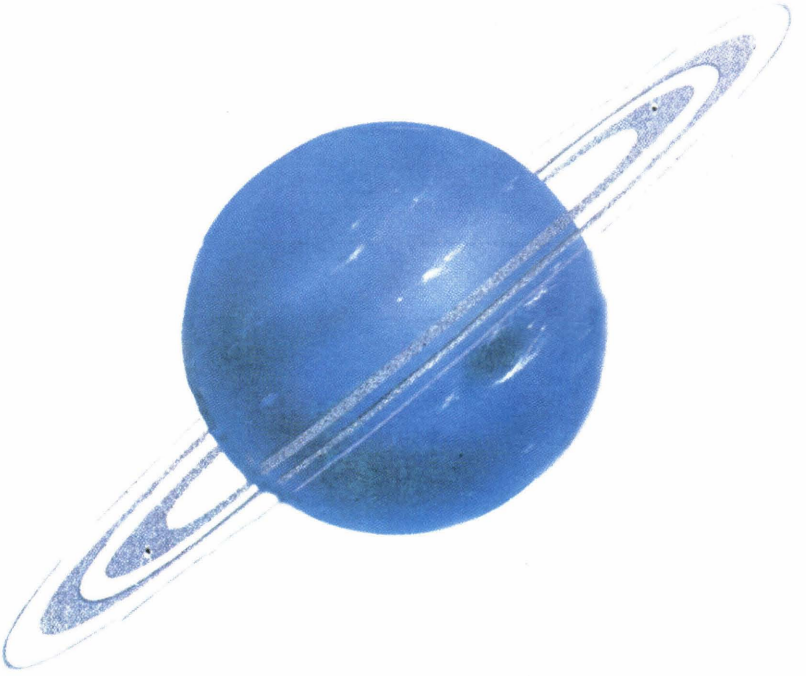
Planet Saturn



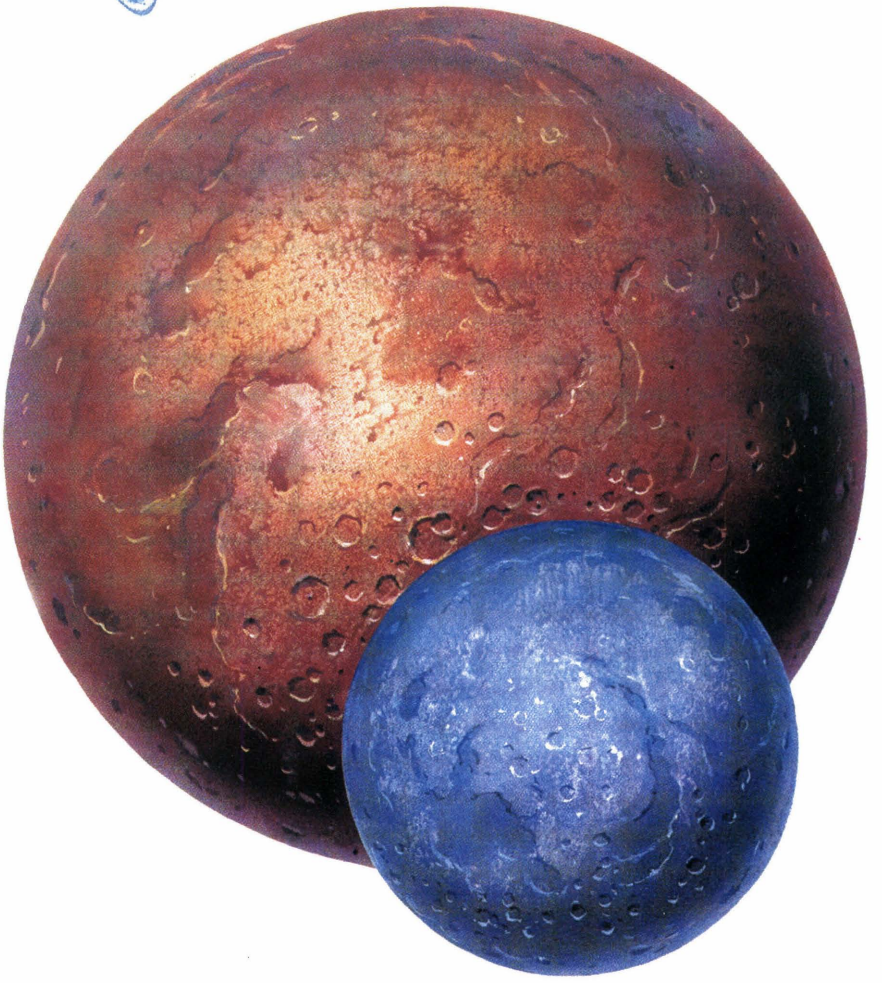
Saturn's Rings



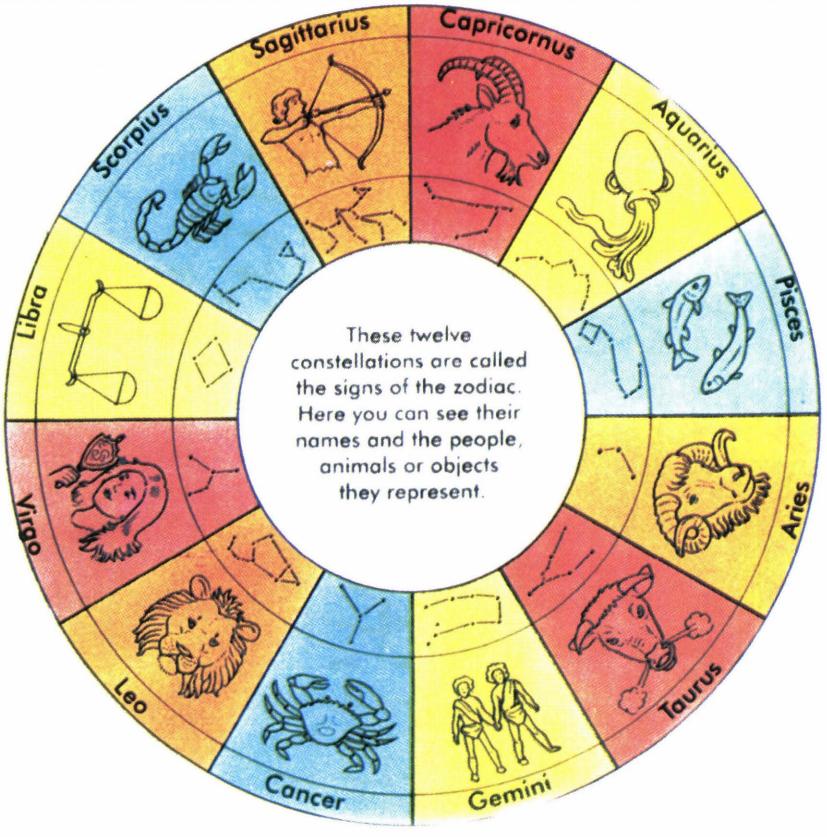
Planet Uranus



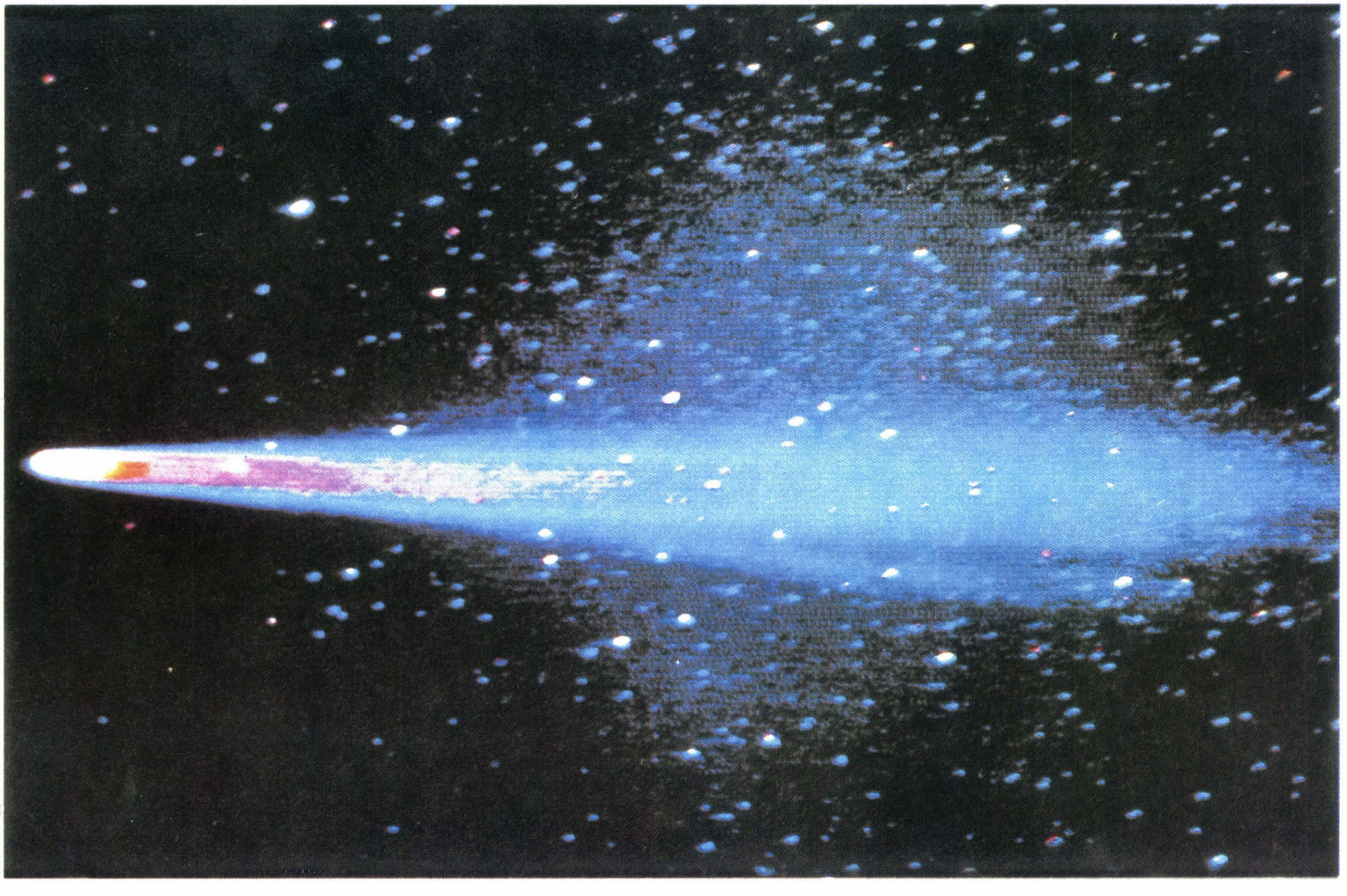
Planet Neptune



Pluto and Charon



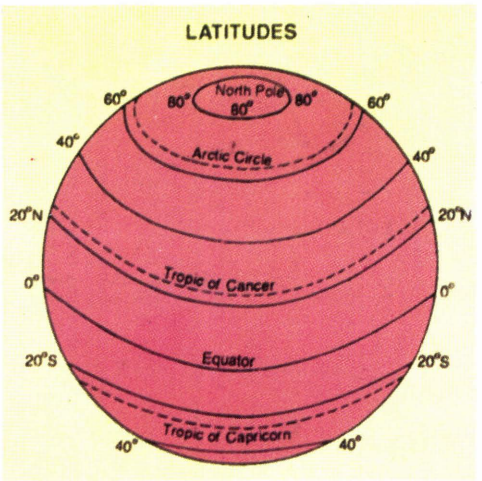
Constellations and the Zodiac



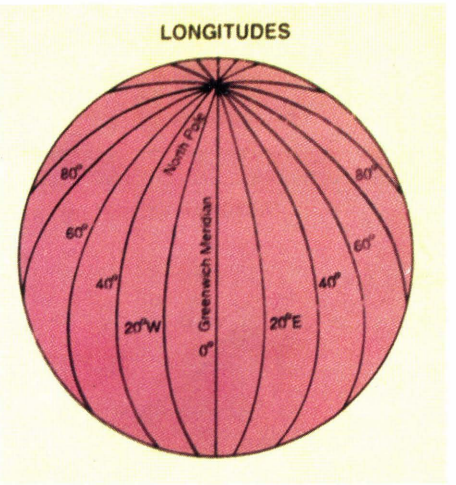
Comet

PART II
The Earth

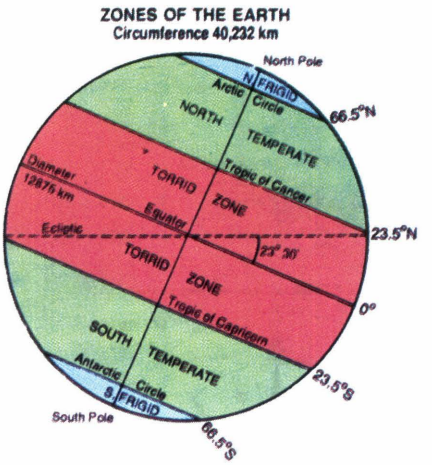
The Earth



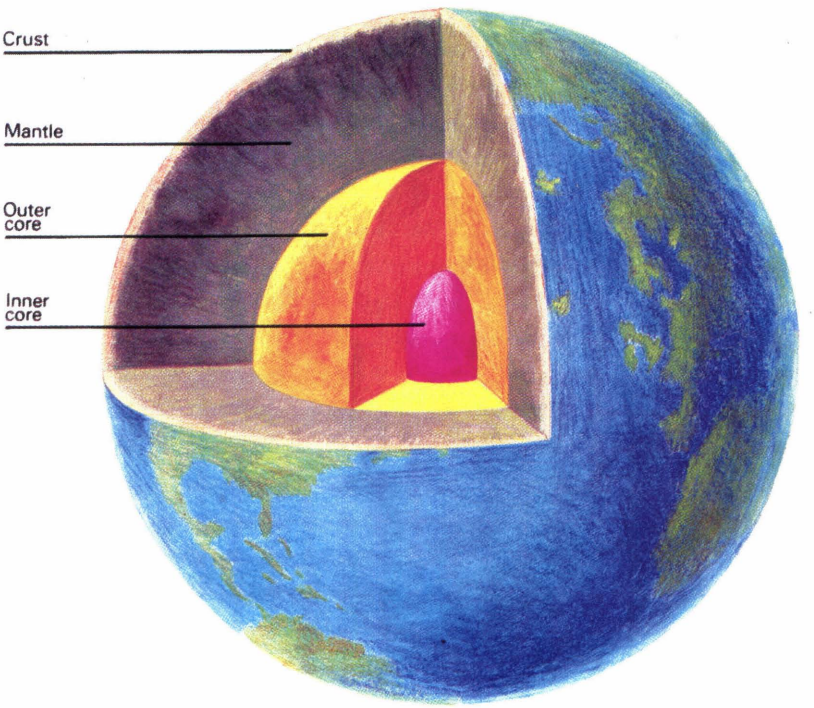
Latitudes



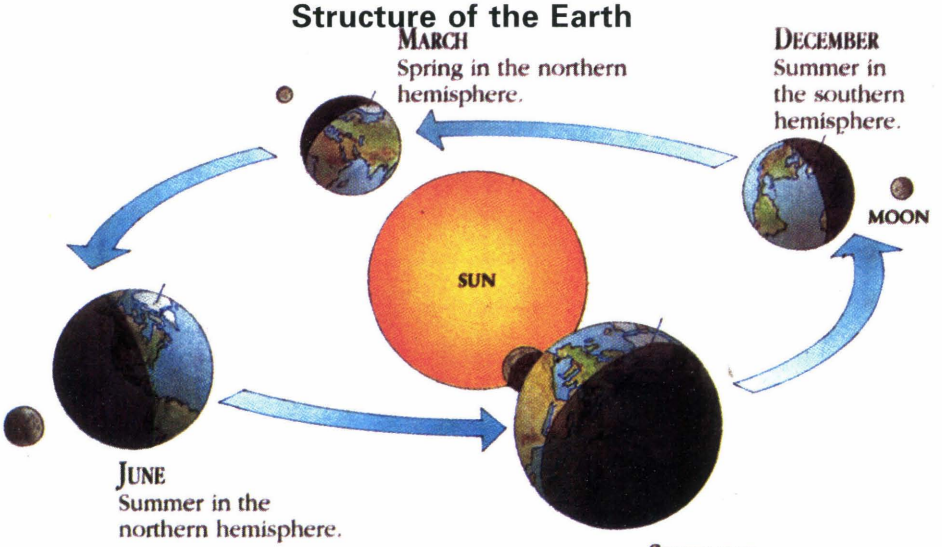
Longitudes



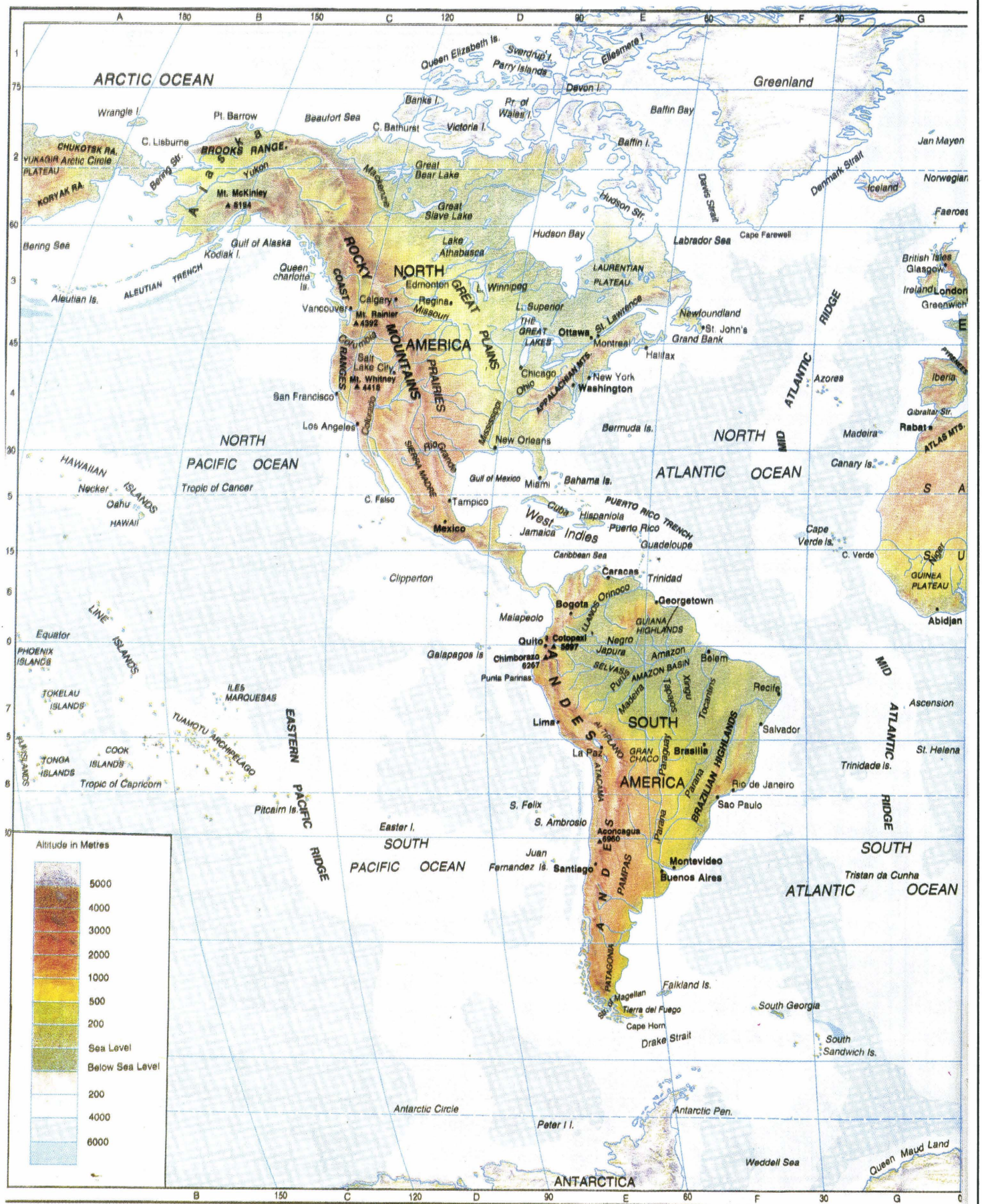
Zones of the Earth



Structure of the Earth



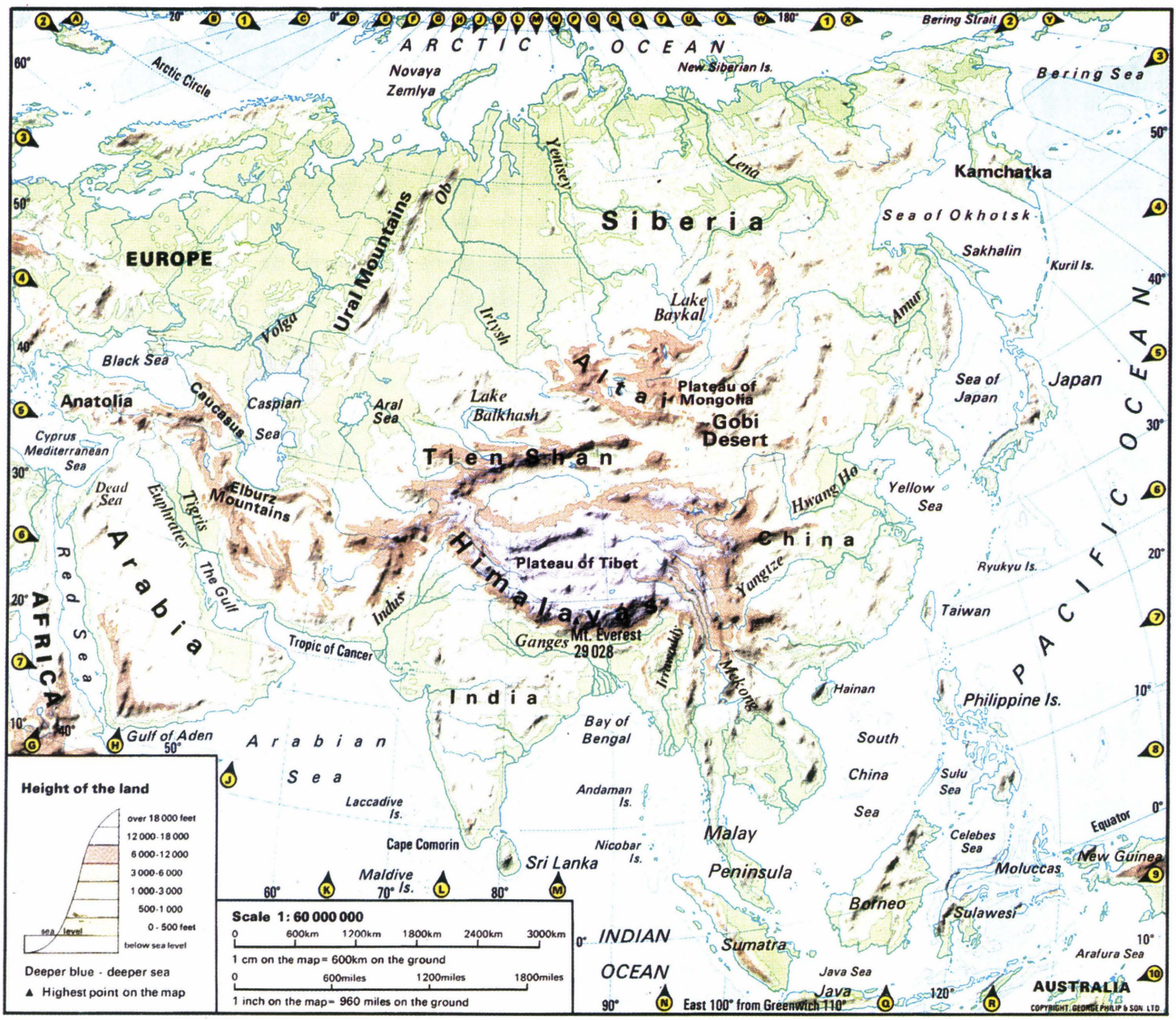
The Seasons, Day and Night


ARCTIC OCEAN
Greenland
Queen Elizabeth Is.
Sverdrup I.
Parry Islands
Ellesmere I.
Devon I.
Banks I.
Pr. of Wales I.
Baffin Bay
Wrangle I.
Pt. Barrow
Beaufort Sea
C. Bathurst
Victoria I.
Baffin I.
Jan Mayen
C. Lisburne
CHUKOTSK RA.
YUKAGIR Arctic Circle PLATEAU
KORYAK RA.
Bering Str.
BROOKS RANGE.
ALASKA
Yukon
Mackenzie
Great Bear Lake
Mt. McKinley ▲ 6194
Great Slave Lake
Davis Strait
Hudson Str.
Denmark Strait
Iceland
Norwegian
Faeroes
Bering Sea
Gulf of Alaska
Kodiak I.
Lake Athabasca
Hudson Bay
Labrador Sea
Cape Farewell
ROCKY MOUNTAINS
COAST RANGES
NORTH AMERICA
GREAT PLAINS
PRAIRIES
Queen charlotte Is.
Edmonton
L. Winnipeg
LAURENTIAN PLATEAU
British Isles
Glasgow
Ireland
London
Greenwich
Aleutian Is.
ALEUTIAN TRENCH
Vancouver
Calgary
Regina
Missouri
L. Superior
Mt. Rainier ▲ 4392
Columbia
THE GREAT LAKES
Ottawa
St. Lawrence
Newfoundland
St. John's
Grand Bank
RIDGE
Montreal
Halifax
Salt Lake City
Mt. Whitney ▲ 4418
Chicago
Ohio
New York
Washington
APPALACHIAN MTS.
ATLANTIC
Azores
Iberia
San Francisco
Colorado
Los Angeles
Mississippi
Bermuda Is.
Gibraltar Str.
Rabat
Madeira
ATLAS MTS.
NORTH PACIFIC OCEAN
Rio Grande
SIERRA MADRE
New Orleans
NORTH ATLANTIC OCEAN
MID
HAWAIIAN ISLANDS
Necker
Oahu
HAWAII
Tropic of Cancer
Gulf of Mexico
Miami
Bahama Is.
Canary Is.
S A
C. Falso
Tampico
Cuba
Hispaniola
PUERTO RICO TRENCH
West Indies
Jamaica
Puerto Rico
Guadeloupe
Cape Verde Is.
C. Verde
Mexico
Caribbean Sea
Caracas
Trinidad
Clipperton
GUINEA PLATEAU
Abidjan
Georgetown
Orinoco
LLANOS
Bogota
Malapeolo
GUIANA HIGHLANDS
LINE ISLANDS
Equator
PHOENIX ISLANDS
Quito
Cotopaxi ▲ 5897
Negro
Japura
Amazon
Belem
Galapagos Is
Chimborazo ▲ 6267
SELVAS
AMAZON BASIN
Purus
Madeira
Tapajos
Xingu
Tocantins
Recife
Punta Parinas
ILES MARQUESAS
TOKELAU ISLANDS
Lima
ANDES
SOUTH AMERICA
ALTIPLANO
GRAN CHACO
Brasilia
Salvador
Ascension
MID ATLANTIC RIDGE
TUAMOTU ARCHIPELAGO
EASTERN PACIFIC RIDGE
La Paz
ATACAMA
Paraguay
Parana
BRAZILIAN HIGHLANDS
St. Helena
Trinidade Is.
TONGA ISLANDS
COOK ISLANDS
Tropic of Capricorn
Rio de Janeiro
Sao Paulo
Pitcairn Is.
S. Felix
S. Ambrosio
Aconcagua ▲ 6960
Easter I.
SOUTH PACIFIC OCEAN
Juan Fernandez Is.
Santiago
PAMPAS
Montevideo
Buenos Aires
SOUTH ATLANTIC OCEAN
Tristan da Cunha
PATAGONIA
Falkland Is.
Str. of Magellan
Tierra del Fuego
South Georgia
Cape Horn
Drake Strait
South Sandwich Is.
Antarctic Circle
Antarctic Pen.
Peter I I.
Weddell Sea
Queen Maud Land
ANTARCTICA
Altitude in Metres
5000
4000
3000
2000
1000
500
200
Sea Level
Below Sea Level
200
4000
6000

The World

(Physical) Natural

Map of the Europe



Map of the Asia

Map of the Africa

Map of the North America

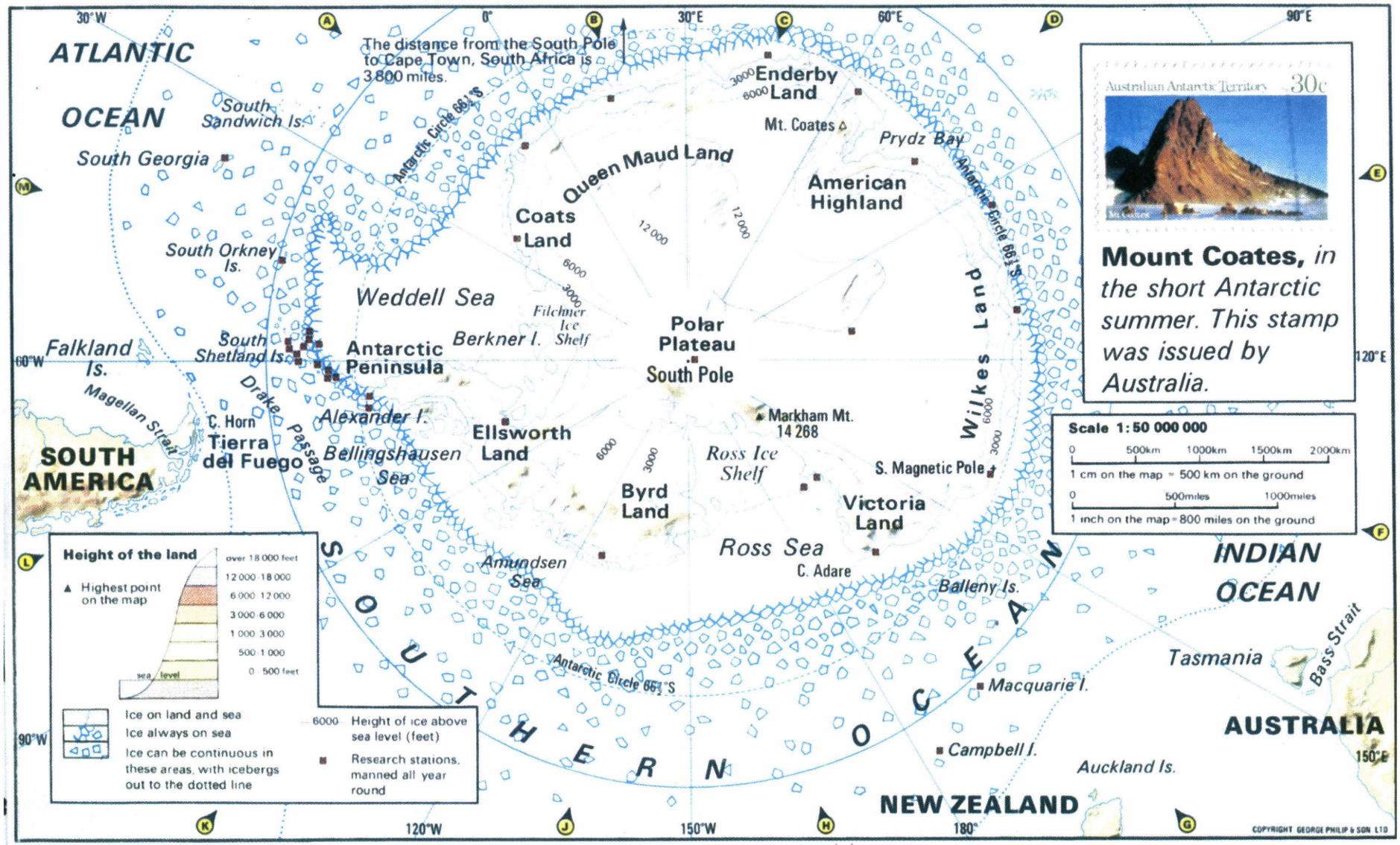
Map of the Central America and Mexico

Map of the South America

Map of the Australia

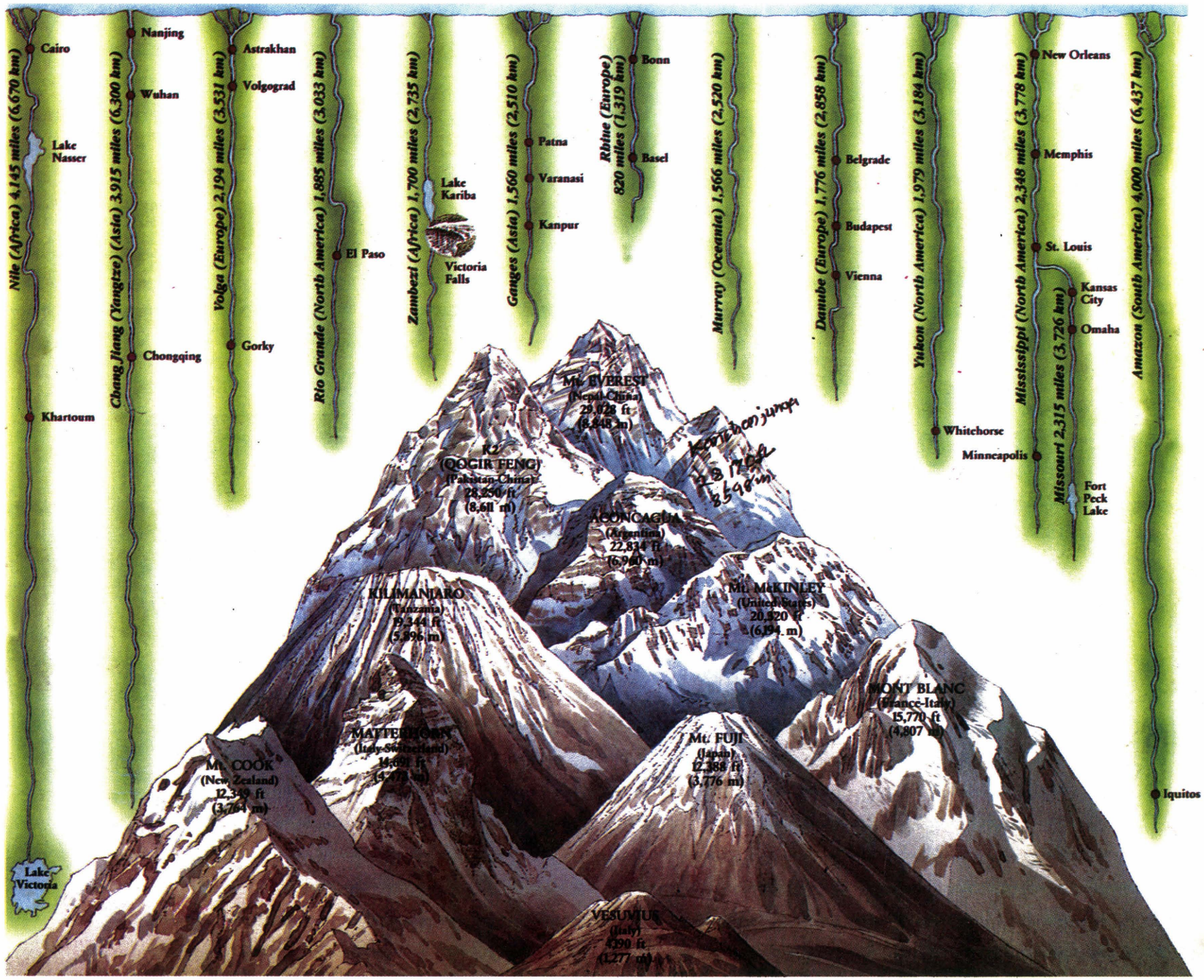
Map of the New Zealand

Map of the Arctic Circle



Mount Coates, *in the short Antarctic summer. This stamp was issued by Australia.*

Map of the Antarctic Circle



Important Rivers and Mountains