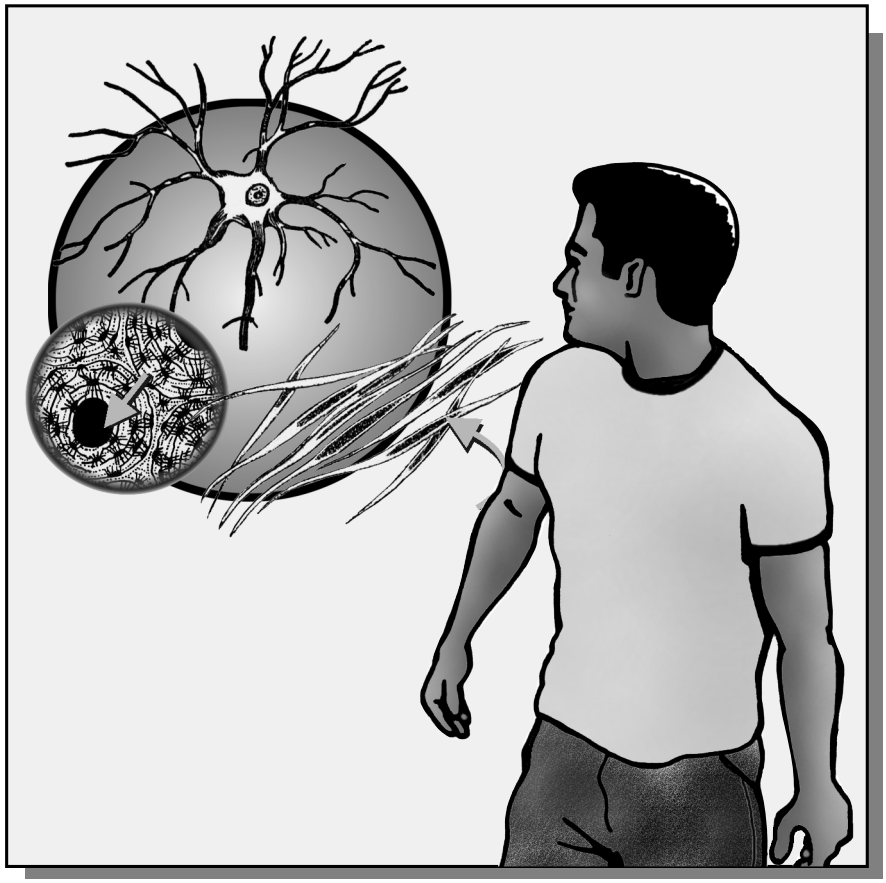
Basic Science Mysteries



Chapter 4

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Basic Science
Mysteries
Chapter 4

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CHAPTER 4
TABLE OF CONTENTS

PAGE

SECTION 1

1. FAR AWAY DISTANCES 3-6
Distances on Earth and in the Solar System

2. THE SUN 7-10
Composition, Energy and Characteristics

3. MERCURY. 11-13
Composition and Characteristics

4. VENUS. 15-17
Composition and Characteristics

5. EARTH. 19-22
Composition, Characteristics and Comparisons

SECTION 2

6. LIFE ON EARTH 23-28
Theories of Origin, Scientific Laws

7. MARS. 29-31
Composition, Characteristics, Comparisons and Conjectures

8. EVERYTHING IS MOVING . . . 33-36
Gravity, Velocity, Friction

PAGE

9. JUPITER 37-40
Composition, Characteristics and Comparisons

10. SATURN 41-43
Composition, Characteristics and Comparisons

SECTION 3

11. STARS. 45-48
Constellations, Light Distances and Star Magnitude

12. URANUS 49-51
Composition, Characteristics and Comparisons

13. NEPTUNE 53-55
Composition, Characteristics and Comparisons

14. PLUTO 57-60
Composition, Characteristics and Comparisons

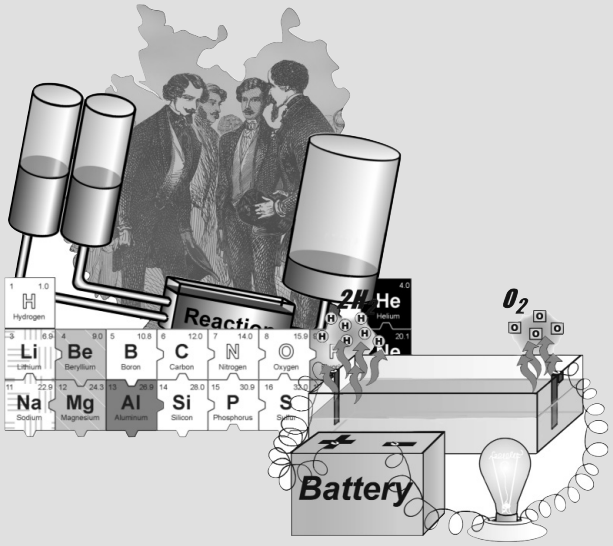
15. IN THE BEGINNING 61-68
Scientific Laws, Premises and Theories



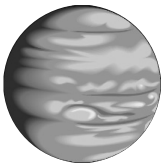
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"By knowledge, understanding and wisdom the true mysteries of life unfold as they are studied line by line and precept upon precept." —Ronald E. Johnson, C.Ph.D.



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Lesson 1
Astronomy

Chapter 4

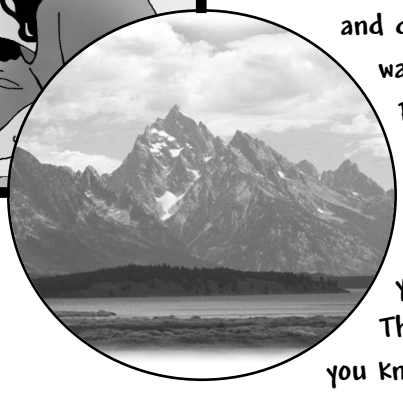
Distances on Earth and in the Solar System

Section 1

Lessons 1-5

FAR AWAY DISTANCES





The phone rang five times before you (Elizabeth) could get to it. You were outside playing with your dog, Princess. No matter how far you threw a ball, Princess would always chase it, *retrieve* it, and drop it at your feet. Then she wanted you to throw it again. Princess never tired of the game, but you did. After you threw the ball a dozen times, you wanted to take a break. The phone gave you that excuse.

The excitement in Maria's voice let you know that the call was special. You and Maria had become friends after she and her family moved to your town from Mexico three years ago. You two girls had most of your classes together, but you got to know her the best during soccer tryouts. Only a select number of players were to be chosen for the team. Maria was really good! When Maria's family lived in Mexico, her dad helped coach Maria's soccer team and had helped improve her skills. You felt sure she would make the team. Your skills weren't as developed as Maria's, and you questioned whether you would be selected.

Maria watched as you practiced working the ball towards the goal. When you would take your shot, your ball would not go very far. Maria told you to use the side of your foot, not the point of your toes, when you kicked the ball. That style seemed natural after you tried it a couple of times. It certainly gave more control and power when you took your shot. When tryouts started, you used her techniques and earned a team position. You were confident that Maria's help enabled you to make the team.

VOCABULARY

Retrieve: to bring back
Fundamentals: basic skills
Astronomer: a scientist who studies the universe
Observatory: a building equipped with telescopes and other scientific equipment to observe the stars
Kilometer: (Km) a unit of measure in the metric system, equal to 1,000 meters
Immense: huge, vast
Enormous: very big
Astronomical unit: a unit used to measure distances in the solar system and is equal to 93 million miles or 149.6 million km.

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Maria's dad invited you to come early to the team practices so he could help you develop the skills that might earn you a starting position. Maria explained that she always arrived early to practices to work on the ***fundamentals***. She was the starting center forward for her team in Mexico, and she credited hard work for earning her that position. Since that day at soccer tryouts, you and Maria had become best friends.

Maria's news was exciting. Her aunt, uncle and cousins from Mexico were planning to visit Maria's family. Since Mexico was so far away, the trip would take several days. The family would stay a week before making the return trip. Maria's parents invited the soccer team to a party the weekend when the cousins were to arrive. Maria's cousins were good soccer players, too, and about your same age. The party would be at the soccer field which Maria's parents had reserved. You, your team, and Maria's cousins would play soccer and then have a cookout. Maria had a special activity planned for after sunset. Maria's uncle was an ***astronomer*** at an ***observatory*** located at one of the universities in Mexico. He was to bring a telescope with him and let everyone get a good look at the stars. All of a sudden, the weekend seemed too far away. You wished it were tomorrow!

Some things are far away. Distance can be measured in several ways. One way to measure distance is in time. You knew that traveling on the interstate to reach your grandmother's house usually took two hours. Sometimes that two hours seemed like a long time. If construction was on the interstate, the trip could take almost three hours. Travel time depended on how fast your dad drove the car.

Another way to measure distance is to use a linear measurement such as a mile or ***kilometer***. Your grandmother's house was about 130 miles away. You thought about Maria's family driving for several days from Mexico before they would reach Maria's house. Mexico was far away from your town.

Mexico is far away unless you live in a border state such as Texas or California. Even then, depending on where you live within those states, you could travel several days before reaching certain points in Mexico. The United States covers a large area, from Canada to Mexico, and from the east coast to the west coast. The distance from the east coast to the west coast is about 3,000 miles. That seems like a long distance if we have to make that trip by car. If we average 60 miles per hour, the trip could be completed in 50 hours of travel time. Then we would have to decide how we want to spend that 50 hours of driving time. We could drive it without stopping except to change drivers when one gets tired and needs to rest. We would also need to determine how fast to drive and how long each day we will drive. The following chart helps you to understand the options you have regarding the time spent to cover a specific distance.

Options for Traveling

Distance to be covered (in miles)	Speed (in miles per hour)	Hours needed to complete trip	Hours traveled each day	Days needed to complete trip
3,000	60	50	10	5
3,000	50	60	10	6
3,000	30	100	10	10

A good way to express some of the data from the above chart is to use formulas. The time (t) required to complete a trip is determined by dividing the distance (d) by the speed (s). That formula would look like this:

$t = d/s$ or *time = distance/speed*

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Using the components of this formula ($t=d/s$), you can also find speed by dividing distance by time ($s=d/t$), or you can determine distance by multiplying speed times time ($d=s \times t$). As long as you know any two components, you can always find the third one by rearranging the formula.

To determine how much time is required to travel 3,000 miles, divide the distance (3,000) by the speed (60 mph). The answer is 50 hours.

To determine how many days is required to complete the trip, just divide the hours needed to complete the trip by the number of hours you will drive each day. If 50 is the number of hours needed to complete the trip, and you are driving for 10 hours a day, 50 divided by 10 equals 5 days required to complete the trip.

Using miles or kilometers to measure distances from one city to another city, or one country to another country works well because the distances are not so far that the numbers are too large to remember or to use in mathematical formulas. In the United States, distances between cities are expressed in miles. Mexico uses kilometers to express distances between cities. Maria's family would drive 1,200 kilometers just to get from their house in Mexico to Maria's house in the United States. This means that Maria's family would be driving 744 miles from one house to the other house. The following chart illustrates how to convert kilometers into miles and miles into kilometers.

Converting Kilometers to Miles

kilometers x .62 = miles
miles / .62 = kilometers
example: 1,200 kilometers x .62 = 744 miles
744 miles / .62 = 1,200 kilometers

Using the same units of measure to determine distances on Earth and in space becomes awkward because distances in space are so ***immense***. When the distance between planets or stars is expressed in miles or kilometers, the numbers are so large that they are difficult to manage. The distance from the Earth to the Sun is 93 million miles or, when expressed in kilometers, is 149,600,000 kilometers. Consider that the Sun is our closest star, and you will see that the numbers used in expressing distance to another star would be huge when expressed in miles or kilometers. Scientists have developed a unit of measure to express these ***enormous*** distances found in space. The ***astronomical unit*** (AU), is a unit used to measure distances in the solar system and is equal to 93 million miles, or 149,600,000 kilometers. Since that is the distance from Earth to the Sun, we say that the distance from Earth to the Sun is one AU.

Observe the table below to determine distances between the nine planets of our solar system and the Sun. Notice that the smaller numbers in the right hand column are represented by astronomical units.

Planet	Distance from Sun (km)	Distance from Sun (AU)
Mercury	57,900,000	0.387
Venus	108,200,000	0.723
Earth	149,600,000	1.000
Mars	227,900,000	1.524
Jupiter	778,400,000	5.203
Saturn	1,427,000,000	9.539
Uranus	2,898,600,000	19.182
Neptune	4,520,000,000	30.214
Pluto (dwarf planet)	5,899,900,000	39.439

Distances in space are much greater than any distance on Earth. Although the Sun can appear very close to Earth, especially in the evening during sunset when it looks like a big orange ball sinking slowly in the sky, in reality the Sun is 93 million miles away from Earth. Maria's cousins would have to make the round trip drive from Mexico about

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drive from Mexico about 62,500 times to cover the same distance as the Earth to the Sun. Now, that would be a long trip!

After your phone conversation with Maria, you returned outside. Princess was sitting by the ball waiting for you. As you threw it, you thought about how far Princess had to run to retrieve it. You wondered if the distance seemed far to Princess. You thought about Maria's family traveling such a long distance. The weekend seemed so far away. If you had only known what was going to happen that weekend, you might not have wanted time to pass so quickly! But we will learn more about that adventure in another lesson.

Note: Until August, 2006, Pluto was classified as a planet, now Pluto is considered to be a "dwarf planet" and is no longer included in scientific charts which list planets.

Life Principle

"'Tis distance lends enchantment to the view, and robes the mountain in its azure hue."

—Thomas Campbell



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Lesson 2
Astronomy

Chapter 4

Composition, Energy and Characteristics

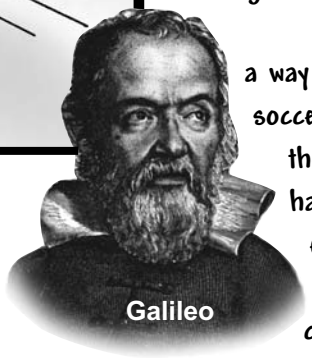
Section 1

Lessons 1-5

THE SUN



Princess knew the routine. Each evening after dinner you helped clear the table and clean the kitchen. When you started putting on your tennis shoes, Princess started wagging her tail. She knew what was about to happen. You reached for her leash and started toward the front yard. You looked at your watch. It was time for your evening jog, and you always took Princess with you. Your route covered a distance of three miles. You alternated walking, jogging, and running as you traveled among the streets of your neighborhood.


Galileo

Maria's father had suggested jogging as a way to improve your endurance during the soccer games. He was right. Each evening for the past several months, you and Princess had faithfully established a pattern of exercise to include a warm-up activity, jogging alternated with running, and a cool-down activity. When you first started, all you could accomplish was walking a mile without tiring. As the weeks progressed, you added jogging and running as well as increasing the distance. During soccer games, you didn't get as tired as you used to. You certainly didn't get out of breath like you previously did.

Princess liked those outings. She ran beside you easily, never seeming to tire. She even knew the route you traveled. One evening, several of your neighbors were working in their yards. Michael's dad was mowing his yard. You wondered where Michael was. Sometimes he jogged a block or two with you. Just past Michael's house, a van blocked the sidewalk and you had to slow your pace to get around it. Two men were unloading some boxes.

VOCABULARY

Horizon: where the Earth appears to meet the sky
Energy: available power for vigorous activities
Photosynthesis: food-making process in plants
Nuclear reaction: a reaction in which nuclei of elements change into nuclei of other elements
Atoms: tiny particles which make up all matter
Fuse: to join together by heat
Nuclear energy: energy given off as a result of a nuclear reaction

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In the next block, you slowed down in front of a house with green shutters. Princess started barking. It was a "happy" bark. Her barks let you know what to expect. Each evening at this house, your friend, LaToya, came outside to talk with you while you rested for a minute. LaToya usually brought a doggie treat for Princess. That was why Princess was sounding one of her "happy" barks.

LaToya was also on your soccer team and had just completed her phone call with Maria about the party. While Princess munched on her treat, you and LaToya talked about the weekend activities. You anticipated having an enjoyable time at a party with your friends. Everyone on the soccer team was cheerful and friendly. Even though practices were hard work, your coach made practice fun. Being with the team was always a bright spot in your week.

The Sun started to set, and you had to head back home. The Sun looked like a huge orange ball sinking slowly below the ***horizon***. The sky was filled with pink, orange, and lavender clouds. You were so busy looking at the sky that you almost tripped over a bundle of wire beside the van that was still blocking the sidewalk.

VOCABULARY

Protons: positively charged particles at the center of an atom
Electrons: negatively charged particles that orbit around the nucleus of an atom
Sunspot maximums: a period of time in which a large number of sunspots occur
Prolonged: for a long period of time
Ultraviolet rays: solar radiation
Dehydration: deprived of water

Princess gave a low growl as you jumped over the supplies and continued home. You were not watching the sidewalk closely because you did not want to miss a second of such a lovely sunset.

The Sun appears to rise in the east and set in the west, which makes us think that the Sun moves across our sky during the day. In reality, the Sun does not move across the sky. The Sun only appears to move because the Earth is spinning.


Nicolaus Copernicus

Nicolaus Copernicus, a 16th century Polish astronomer, was the first person to suggest that the Earth revolved around the Sun. Until that time, common belief was that the Sun revolved around the Earth. We are still learning about the Sun and the role it plays in our existence on Earth.

The Sun supplies Earth and the entire solar system with ***energy***. We could not live without the Sun. Energy from the Sun is essential for plant growth and development. All the energy in an ecosystem begins with the Sun. Plants use light energy from the Sun to carry out the food-making process called ***photosynthesis***. The food produced by a plant is stored as chemical energy within the plant. The plant uses this stored chemical energy in carrying out its life processes. Then animals that eat the plant use the stored energy to carry out their life processes.

Energy from the Sun affects air and water masses, changes in weather patterns and ocean currents. Energy from the Sun can be transformed into heating and lighting appliances. Energy from the Sun can even be used to power batteries and fuel cars. Almost everything we do depends on energy from the Sun.

The Sun is a star and is considered to be of average age and temperature. The actual brightness of the Sun is also about average brightness for a star of its size. Because

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the Sun is much closer to Earth than any other star, the Sun appears very large and bright.

The Sun is a huge ball of gases, mostly hydrogen and helium. The Sun is made up primarily of 71% hydrogen and 27% helium. The remaining 2% is a combination of other elements. These gases are so hot that they make the Sun glow; however, the gases are not burning. Burning is a chemical reaction and is not occurring on the Sun. Another type of reaction is occurring, one which is called a ***nuclear reaction***.

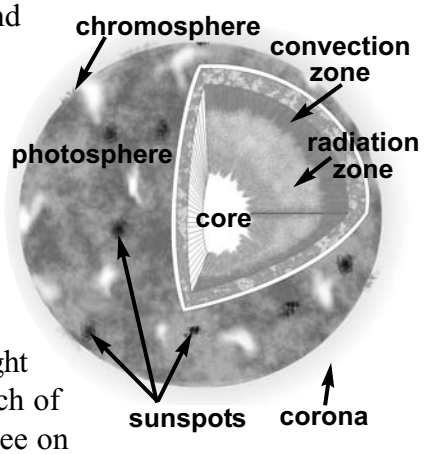
Heat and pressure inside the Sun cause ***atoms*** of hydrogen and helium to ***fuse***, or join together, producing ***nuclear energy***. Under such conditions, hydrogen atoms are separated into ***protons*** and ***electrons***. Protons move so fast they crash into each other and sometimes stick or fuse together. This combining of particles is called fusion. During several steps, fusion builds hydrogen into helium and results in production of a tremendous amount of heat and light.

Temperature Ranges of the Sun Listed in Degrees Fahrenheit	
at the core	29,000,000 degrees
on the surface	9,300 degrees
in a sunspot	8,100 degrees
in the corona	1,800,000 degrees

The Sun consists of a series of layers. The *core* is the site of nuclear fusion. The core (center) is the Sun's nuclear power plant and is the hottest part of the Sun.

Just outside of the core is a *radiation zone* in which energy bounces back and forth before it escapes to the convection zone. Energy from the core radiates outward through this layer of hydrogen and helium gas into the convection zone.

The *convection zone* carries energy from the Sun's core to its surface. This is a cooler layer of gas that is constantly rising to the surface and sinking back.



The *photosphere* is the Sun's visible surface. The photosphere is the incredibly bright source of much of the light we see on Earth.

The *chromosphere* is the inner atmosphere of the Sun. The chromosphere is an active layer with huge flares and loops of hot gas often shooting outward.

The *corona* is the Sun's outer atmosphere. Although it is extremely hot, gas in the corona is spread very thinly and serves as a gradual boundary between the Sun and space.

The Sun often appears as a smooth ball, but it is not. Scientists have ways of studying the Sun without looking at it directly. Never look directly at the Sun because severe eye damage, even blindness, may result. Solar telescopes use a series of mirrors to reflect light from the Sun down into an underground observation room where the light can be studied. Scientists have learned that the Sun has dark areas on the surface that are cooler than surrounding areas. Such a cool, dark area on the Sun's surface is called a *sunspot*. Gases do not move very much in sunspots. Cooler gas shines less brightly than hotter gas, so sunspots appear darker than the areas around them.

Galileo, an Italian astronomer in the 1500-1600s, was the first scientist to identify sunspots. Scientists have continued to study sunspots since Galileo's discovery. Spots may appear and disappear over a period of several days or several months. Sometimes many

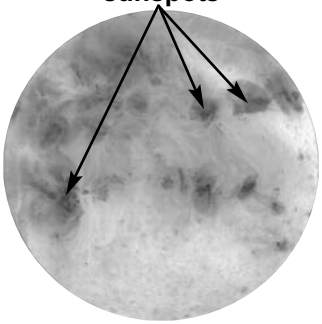
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large sunspots are visible; while at other times only a few small spots, or none at all are evident. ***Sunspot maximums*** (large numbers of sunspots) seem to occur about an average of every eleven years, affecting Earth's magnetism and electric power transmissions. This cycle is often called the *cycle of solar activity*.



Galileo

Something else that scientists have learned by studying the sunspots is that the Sun rotates. Astronomers can observe the movement of individual sunspots as they are carried by the Sun's rotation. Because the Sun is made up of gases, it does not rotate as a solid body, the way Earth does. The Sun rotates faster at its equator than at its poles. Sunspots at the equator go around the Sun in about 25 days. Sunspots near the poles go around the Sun in about 35 days.



The Sun is necessary for life on Earth to exist. However, some features of the Sun can be harmful. ***Prolonged*** exposure to ***ultraviolet rays*** from the Sun can cause skin cancer. Sunscreen or protective clothing should be worn when you are out in the sunlight for long periods of time. In addition, heat exhaustion or heat stroke can occur if you get too hot. Be sure to drink a lot of fluids to prevent ***dehydration*** when outside during summer months.

As you and Princess reached home, the Sun sunk below the horizon. Clouds were still various shades of pink. You were putting the leash up on the nail in the garage when you heard Princess growl. You did not notice anything unusual, so you told her to be quiet and go inside. A van with two men inside slowly pulled away from your curb. You did not notice them, but Princess did. You were tired from your run and started to do a few stretching exercises as you cooled down. Later, you were glad that Princess wasn't as tired as you were!

Life Principle

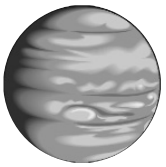
"Like a ray of sunshine, a cheerful word can brighten your day."



—Anonymous

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Lesson 3
Astronomy

Chapter 4

Composition and Characteristics

Section 1

Lessons 1-5

MERCURY



Soccer practice was going very well for you. You seemed faster than usual. Your coach accused you of having wings on your feet! Maria's dad worked with you and Maria for about 30 minutes before practice began, showing you how to shift your weight quickly from one foot to the next to maneuver the ball around a defender. All that work on the fundamentals proved beneficial. The coach was considering you for right forward. Your first game was in two days. The party with Maria's family and the team was just one day later. The week seemed to fly by. Your coach let you know that if you kept those wings on your feet, you would start at right forward. Things were happening so fast!



VOCABULARY

Mythology: the study of ancient Greek and Roman myths (legends about fictional characters and events)
Terrestrial planets: planets which are similar to Earth in size and composition
Celsius: a unit of measure for temperature in which the boiling point of water is 100ºC and the freezing point of water is 0 degrees
Fahrenheit: a unit of measure for temperature in which the boiling point of water is 212ºF and the freezing point of water is 32ºF

Roman ***mythology*** pictures the messenger god, Mercury, as having winged feet to move him swiftly across the heavens. Because Mercury changes positions in the sky so quickly, astronomers chose the name Mercury for the planet closest to the Sun in our solar system. Mercury flies along in its orbit faster than any other planet, traveling at 29 miles per second, which is the equivalent of 47.89 kilometers per second. The table on the right shows a comparison of the average

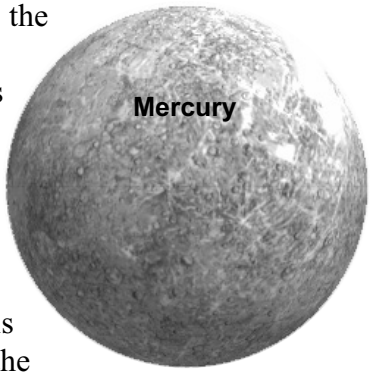
Average Orbital Speed of Planets

Planet	Orbital speed in km/s
Mercury	47.89
Venus	35.03
Earth	29.79
Mars	24.13
Jupiter	13.06
Saturn	9.64
Uranus	6.81
Neptune	5.43
Pluto	4.74

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orbital speeds of the planets in kilometers per second. Mercury is appropriately named!

Mercury, Venus, Earth and Mars make up the group of planets known as ***terrestrial planets***. Their surfaces are composed of solid rock and dirt. Because of the size and composition of these planets, they are classified as Earth-like, or terrestrial planets.


Mercury

Mercury is the planet nearest the Sun. Temperatures on the daylight side of Mercury may reach 425º ***Celsius***. On the ***Fahrenheit*** scale, that is 810º. That is much hotter than the specifically designed, high-temperature ovens at pizza places. On the night side of Mercury, temperatures can fall to a ⁻175º Celsius. A Fahrenheit equivalent would be ⁻290º. That is much colder than temperatures recorded at the North Pole here on Earth, even when figuring in a wind chill factor! Mercury is one of the hottest and coldest planets in the solar system.

VOCABULARY

Craters: deep cavities or holes made on a surface
Meteors: relatively small pieces of rock or metal which passes through Earth's atmosphere in a fiery streak; sometimes called "shooting stars"
Mass: a quantity of matter
Comets: large, dense masses of frozen gas and rock orbiting the Sun in long elliptical orbits; have long "tails" of dust resembling long hair; most famous is Halley's Comet, seen once every 76 years

Until 1965, scientists thought that the same side of Mercury always faced the Sun. Then astronomers discovered that Mercury *rotates* on its axis once every 59 days. Earth rotates on its axis once every 24 hours. Mercury *revolves* around the Sun in 88 days compared to Earth's 365 days. Mercury completes three full turns on its axis for every two orbits around the Sun. Because of this motion we see the same side of Mercury each time it comes closest to Earth.

Our first close look at Mercury came in 1974 when the unmanned U.S. spacecraft, *Mariner 10*, passed close to the planet and

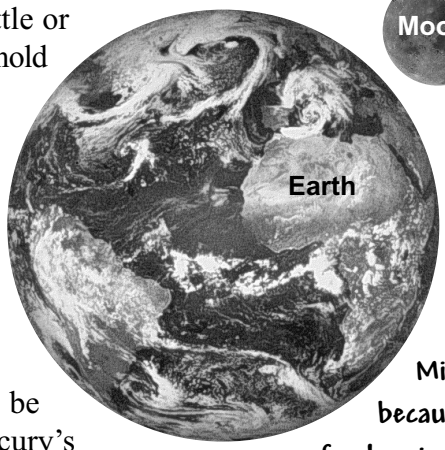

Mariner 10

sent pictures back to Earth. The surface of Mercury looks much like the surface of our Moon, pitted with ***craters*** from ***meteors*** and covered with a thin layer of fine dust. Mercury has huge cliffs; some are over a mile high. Mercury is a rocky planet, with a core that is probably made of nickel and iron. *Mariner 10* made three passes near the planet in 1974 and 1975. Mariner photographed most of the planet's surface, measured temperatures and discovered a weak magnetic field. Because it has a magnetic field, the outer core of the planet must be a liquid iron compound, which produces a magnetic field as it moves.

Mercury is the second-smallest planet in the solar system. Only Pluto is smaller. Mercury's diameter is about 0.38 that of Earth. Its ***mass*** is about 0.06 that of Earth. Because of its small mass, Mercury exerts a weak gravitational force compared to other planets. It has almost no atmosphere because such little gravitational force exists to hold an atmosphere in place. Sodium and potassium

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make up the scanty atmosphere Mercury has. Because little or no atmosphere exists to hold in the heat, temperatures drop drastically at night when the planet is not facing the Sun.



Astronomers are still learning about Mercury. In 1991, a powerful radio telescope depicted what appears to be vast sheets of ice in Mercury's polar regions. *Mariner 10* did not travel by Mercury's polar regions, so no photographs were taken for comparison. Scientists speculate that these ice caps might have formed by icy ***comets*** gouging deep craters at the poles. The floors of these craters remain in perpetual shadow, preventing the Sun from melting the ice.

Mercury's diameter measures 4,879 kilometers. That is about one-and-a-half times that of Earth's Moon. The diameter of Earth measures 12,756 kilometers. To compare the sizes of the planets, imagine that Earth is the size of a baseball. Mercury would be the size of a golf ball in comparison.

The United States has made no plans for a manned spacecraft to go to Mercury. In the daytime, Mercury is hotter than a normal oven. At night it is colder than even the most frigid spots on Earth. Solar radiation on Mercury is too strong for humans to endure without special protection. There, the Sun would look almost three times as large as it does from Earth. Mercury has no air, no water, and nothing can grow on the planet's surface. Humans could not survive on Mercury.



Your "winged feet" helped you cover your evening jog in record time. Even Princess seemed to notice how fast you were. She was not pulling on her leash because you were not lagging behind her as you jogged. She slowed down when you got to Michael's house. That was unusual because she knew that a treat was waiting for her in the next block at LaToya's house. The hair on the back of her neck stood up and you heard a low growl. Michael's family was nowhere to be seen, although a van was parked in the driveway. You pulled on Princess' leash to get her going. Something was not right, but you were not sure what. You continued jogging because other thoughts occupied your mind. You probably would start at right forward. You hoped you would not lose those wings on your feet. You could not imagine how much you would need them later.



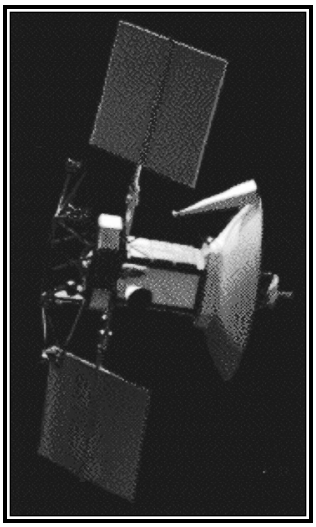
Life Principle

"Know what you're running towards if you expect to reach your destination."

—Anonymous

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Lesson 4
Astronomy

Chapter 4

Composition and Characteristics

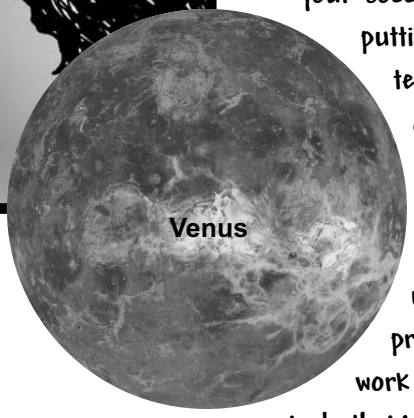
Section 1

Lessons 1-5

VENUS



You went to bed but could not get to sleep very easily. Thoughts of Maria's party filled your mind. You wondered whether her cousins would be friendly, and what kind of soccer players they were. Maria was really good at the sport so you inferred that her cousins would be just as good or even better. Maria's dad would divide your soccer team into two smaller teams, putting two of Maria's cousins on one team and two on the other so you could play an actual game. That should be fun. Maria talked often about her family from Mexico. Her uncle was coming to a nearby university as a consultant on a project sponsored by *NASA*. His work as an astronomer was recognized in both Mexico and the United States. You would enjoy meeting him and getting to look through the telescope he was to bring.



You pulled back your bedroom curtains to get a look at the stars. Unfortunately, some type of fog had settled in, and you had difficulty seeing the street light at the end of your block. You could barely make out the shapes of a car and truck as they drove by. The fog was really thick. You heard Princess bark a few times. She slept in the backyard in her doghouse unless the weather was unusually cold, then your mom let Princess inside to sleep in your bedroom. You hoped the fog would lift by morning. Going anywhere in a thick fog would be hard. Princess barked again. You saw the shape of a van turning into your driveway and then backing out again. You decided that the driver got mixed up because of the

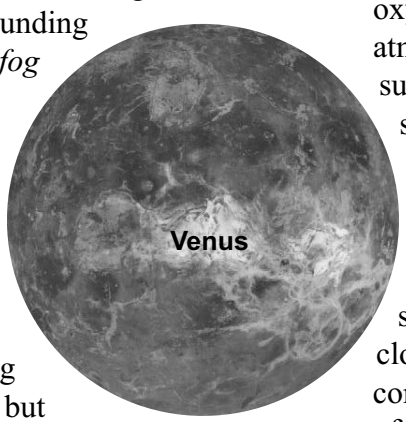
VOCABULARY

NASA: National Aeronautics and Space Administration
Perpetually: lasting for an indefinitely long time; ongoing
Sulfuric acid: a poisonous, highly corrosive acid
Stagnant: not moving
Carbon dioxide: a colorless, odorless gas
Greenhouse effect: when gases in the atmosphere (such as carbon dioxide) trap solar radiation causing a buildup of surface heat
Atmospheric pressure: weight or pressure exerted by gases in the atmosphere

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fog and had pulled into the wrong driveway. The hour was late so you crawled back into bed. As you slept, the fog thickened.

In the same way that you have problems seeing clearly through fog, so do astronomers as they look through a thick layer of clouds surrounding the planet, Venus. A *fog* is a cloud that forms close to Earth's surface. Fortunately, fog usually lifts when the air becomes warmer.



The blanket of clouds surrounding Venus will never lift but will ***perpetually*** shield its surface from view. This cloud base hovers at 50 km (31 miles) above the surface of the planet. The cloud particles are mostly concentrated ***sulfuric acid***. On Venus, the poisonous acid evaporates at the cloud base and remains in the atmosphere. The sulfuric acid gives the clouds a yellowish color. Certain cloud patterns and weather features can be discerned in the cloud tops that indicate wind motion in the atmosphere. These are high-speed, upper-level winds which are located high above the planet. The dense atmosphere near the planet's surface, however, is almost ***stagnant***.

Beneath this cloud layer lies an atmosphere made up mostly of ***carbon dioxide*** gas. Heat from the Sun is trapped by the carbon dioxide and held near the planet's surface. The trapped heat builds up, causing the planet to become hotter and hotter. This causes what is known as the "***greenhouse effect***." Carbon dioxide acts like glass in a greenhouse. It allows incoming sunlight to pass through, but traps and absorbs heat radiated back from the planet's surface, causing temperatures to reach 480º Celsius. Although it is the second planet closest to the Sun, the greenhouse effect makes Venus the hottest planet in our solar system. Venus' temperature is high enough to melt lead.

Carbon dioxide accounts for about 97% of the atmosphere on Venus. This gas is much denser than the mixture of nitrogen and oxygen gases that makes up most of Earth's atmosphere. The ***atmospheric pressure*** at the surface of Venus is 90 times that of Earth's surface. Atmospheric layers in general are made of different amounts and combinations of gases. The gases that make up the air take up space and have mass. Gravity pulls the air toward the ground the same as gravity pulls any other mass. The closer the air is to the surface, the more compressed the air becomes under the weight of the layers pushing down from above. Since the atmosphere on Venus is much denser than the atmosphere on Earth, the atmospheric pressure is greater on Venus. The weight of the atmosphere would crush anyone standing on Venus. That is reason enough not to go there!

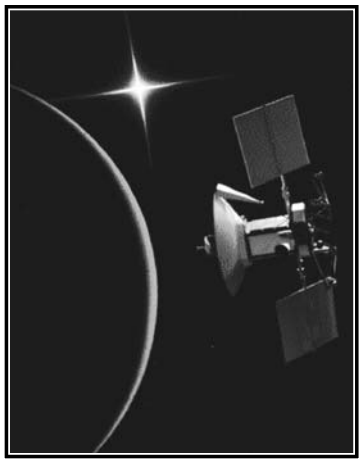
Percentages of Gas in the Atmosphere

	carbon dioxide	nitrogen	oxygen	water vapor
Venus	96.5	3.5	0.002	0.01
Earth	0.03	78.1	20.9	1.05-4.0

Daytime on Venus is about as bright as a cloudy day on Earth because of Venus' perpetual cloud cover. Although Venus' orbit brings it closer to Earth than any other planet, this blanket of clouds has kept much of our neighboring planet a mystery. Most knowledge of the planet has been obtained through the use of space vehicles carrying probes that descend through the atmosphere. The first spacecraft to study Venus was *Mariner 2*, launched by the United States in 1962. Radar revealed that Venus rotates, or spins on its axis, from east to west. Most of the other planets in our solar system rotate from west

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to east. Most of the ground on Venus is flat. The *Magellan* probe, launched toward Venus in 1989, began transmitting radar images of the planet in 1990. *Magellan* discovered mountains on Venus that are higher than any on Earth and also found a valley that is longer and deeper than the Grand Canyon. More evidence indicates that the surface of Venus may contain active volcanoes. Some dust and gravel, but no soil, covers the surface of Venus.



Venus is similar to Earth in diameter and mass. Sometimes Venus is called Earth's "sister planet." The following table has several comparisons between the two planets.

Comparison of Characteristics between Venus and Earth

	Venus	Earth
Diameter	12,104 km	12,756 km
Orbital speed	35.03 km/s	29.79 km/s
Period of rotation	243 days	24 hours
Period of revolution	225 days	365 days
Highest recorded temperature	480° C	58° C

As one of the terrestrial planets, Venus does share some similar characteristics with Earth. However, the differences between the two planets are significant enough that humans could never survive on Venus. Even if humans could survive the heat and the poisonous atmosphere, people would not want every day to be cloudy.

You woke up the next morning to a beautiful, clear, sunny day. Last night's fog had lifted. You dressed and joined your parents for breakfast. Your mom was concerned about a call she had received from Michael's mother. It seemed that Michael's dad had attended a conference last night and had experienced some type of problem. No one was sure what happened, but while he was setting up his laptop computer to use in a presentation, he was distracted. When he returned, the disk from his computer was missing. The disk contained vital information necessary for a project Michael's dad was designing. The hard drives on both his office computer and home computer were infected with a virus and all backup files were destroyed. Michael's mom said it might have been a huge coincidence, but her husband thought his work had been sabotaged. Your parents were concerned, but not alarmed. If they had only known that you were connected to this bizarre set of events, they would have been very alarmed. But then, you did not realize it either! You were, however, soon to find out!

Life Principle

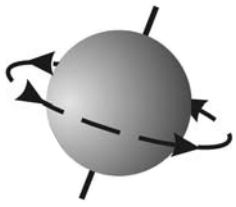
"Do not let worries cloud your view of life."

— Anonymous

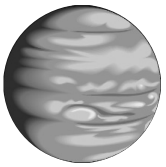


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Lesson 5
Astronomy

Chapter 4

Composition, Characteristics and Comparisons

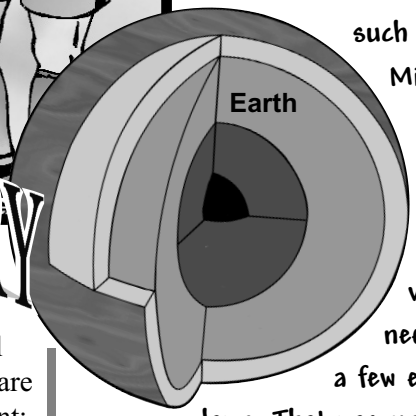
Section 1

Lessons 1-5

EARTH



You liked where you lived. It was a special place. You had friends in your neighborhood you enjoyed, you liked your school, and you were not too far from your church. You even liked the weather where you lived. Most of the days were sunny, even in the winter. Days could get hot in the summer, but a trip to the swimming pool at the park took care of that. You had plenty to do where you lived. You could hunt, fish, camp, take hikes or play sports. Sometimes you just hung out with your friends at the mall or at the convenience store. Michael was one of your closest friends, but you were in such a good mood that even the news about Michael's father didn't disturb you.



You and Michael Rollins had been friends since first grade. His dad was out of town on business frequently; but his mom was usually at school, volunteering her time with whatever needed to be done. You saw Michael's dad a few evenings ago when he was mowing their lawn. That was unusual, because Michael usually did the yard work. According to Michael, his dad was really smart. What happened with his computer must have been some type of computer error that even Mr. Rollins didn't know about. Maybe instead of mowing the yard, he should have been working on his computer; but the problem was not yours, so you forgot about it. With such sunny skies, moderate temperatures, and a soft breeze blowing, the day was too lovely to think about anything else other than how good you felt just to be alive!

VOCABULARY

Sphere: a three-dimensional surface, all points of which are equidistant from a fixed point; a perfectly round ball
Oblate: flattened at the poles
Elliptical: describes an elongated circle; a type of oval
Axis : (mathematical) a reference line from which distances are measured
Perihelion: point nearest the Sun in the orbit of a planet

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The variety of landforms, the oxygen-rich atmosphere, the deep oceans and the huge variety of living things found on Earth all contribute to the beauty and uniqueness of our planet. Earth is a wonderful place to live. Especially considering that it is the only place in the universe that can support life as we know it! If Earth were any closer to the Sun, conditions would be too hot for life to exist. If Earth were any farther from the Sun, conditions would be too cold for life to exist. If Earth's atmosphere were like the atmospheres found on all the other planets, life could not exist. Only on Earth is every detail arranged in such a way to support and sustain life. Scientists have proposed the *Anthropic Principle*, which states that the physical structure of the universe is exactly what is necessary in order to support life. Earth is placed exactly the right distance from the Sun for comfortable year around and daily climates. The rotation and axis tilt provide annual seasons for crops. Its position in the universe "equips" Earth with just the right amount of gravity to sustain life.

In other ways, Earth seems to be just an average planet. It is bigger than four planets in the solar system and smaller than the other four. The diameter of Earth measures 12,756 kilometers. Column A of the following chart compares the diameters of the planets in our solar system.

VOCABULARY

Aphelion: point on the orbit of a planet that is farthest from the Sun
Axis : (Earth's) an imaginary line extending from the North Pole to the South Pole, straight through the center of Earth

Some scientists use a different standard of measure to compare the diameters of the planets. The same data is used in Column B, but it is expressed in a different way. The number one (1.00) represents the diameter of Earth. The numbers representing the diameters of the other planets are determined by comparing their diameters to Earth's diameter in proportion. This type of table will tell you how many times larger or smaller a planet's diameter is in comparison to Earth's. The comparisons are made for you. Those numbers less than one represent planets whose diameters are smaller than Earth's. Those numbers greater than one represent planets whose diameters are larger than Earth's.

Notice that Jupiter has a proportional diameter of 11.19. That means Jupiter's diameter is about eleven times larger than Earth's diameter. The diameter of Mars is represented by the number 0.53, which is the equivalent of about one-half. This table lets you know that the diameter of Mars is about half the size of the diameter of Earth.

Diameters of the Planets

Planets	Column A Expressed in kilometers	Column B Proportional to Earth (at 1.0)
Mercury	4,879	0.38
Venus	12,104	0.95
Earth	12,756	1.00
Mars	6,794	0.53
Jupiter	142,984	11.19
Saturn	120,536	9.46
Uranus	51,118	4.01
Neptune	49,528	3.88
Pluto (dwarf planet)	2,302	0.18

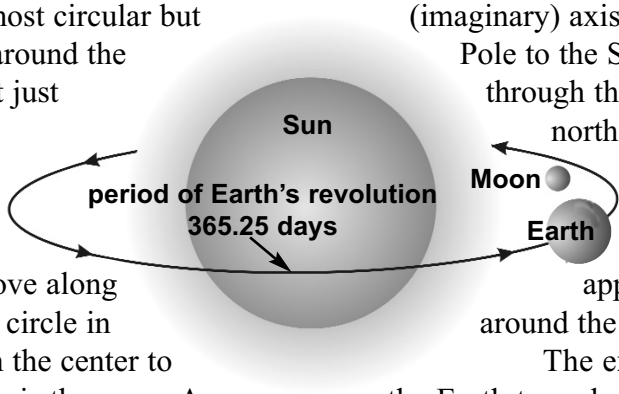
Earth is the third planet from the Sun. Two planets, Mercury and Venus, are closer to the Sun. The other six planets, Mars, Jupiter, Saturn, Uranus and Neptune are farther away from the Sun than is Earth.

The Earth is not a perfect ***sphere*** but

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is slightly ***oblate***, or flattened at the poles. The diameter of the Earth measured longitudinally (lengthwise through the poles) is about 42 km less than the diameter of the Earth measured latitudinally at the equator.

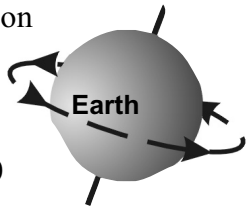
The Earth and its satellite, the Moon, move together in an almost circular but slightly ***elliptical*** orbit around the Sun. All the planets, not just Earth, orbit the Sun in elliptical paths. In an ellipse, the distance from the center to the edge changes as you move along the edge. It is not like a circle in which the distance from the center to any point along the edge is the same. An ellipse has a long ***axis*** and a short axis. They cross at right angles at the center of the ellipse. The Sun is not exactly in the center of the ellipse. For these reasons, the Earth is not the same distance from the Sun at all times.



About January 2nd, the Earth is closest to the Sun. The point nearest the Sun in the orbit of a planet or other celestial body is called the ***perihelion***. For Earth, perihelion occurs on January 2nd. The Earth is farthest from the Sun on July 3. The point on the orbit of a celestial body that is farthest from the Sun is called the ***aphelion***. For Earth, aphelion occurs on July 3rd. For this reason, when you see data tables of planets with their distance from the Sun, the numbers only represent an average distance. Scientists say that the distance from Earth to the Sun is 93 million miles, or 146,600,000 kilometers. That represents an average distance since Earth, like all planets, travels around the Sun in an elliptical orbit, and the distance from the Sun will vary at any point.

The Earth is moving along its elliptical orbit around the Sun with an average orbital speed of 29.79 kilometers per second. This trip, or revolution, around the Sun is accomplished in 365.25 days. That figure is rounded to 365 days, or the period we call one year. This is also called the period of revolution. While revolving around the Sun, Earth also rotates on its ***axis***. Earth's (imaginary) axis runs from the North Pole to the South Pole, straight through the center of Earth. The northern end of Earth's axis always points to the North Star. As the Earth rotates, the stars appear to move in a circle around the North Star.

The exact time necessary for the Earth to make one complete rotation is 23 hours and 56 minutes. That figure is rounded to 24 hours, which is the period we call one day. As the Earth rotates on its axis, everything on Earth rotates along with it, including you! You are traveling at approximately 1,000 miles per hour, and you don't even feel it. That is because Earth and everything on it is also moving at that same speed.



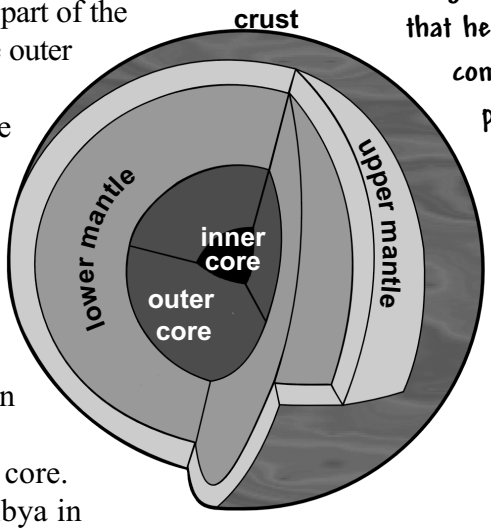
period of Earth's rotation: 23 hours,

Much evidence supports the belief that Earth's sustained rotation establishes a perfect environment to support life. If the Earth did not rotate, day would not change to night. One half of the Earth would have only day. The other half would have only night. The Sun, Moon, and stars seem to move across the sky. They appear to move because the Earth is rotating. Global winds are winds that move across large parts of the Earth. If the Earth did not turn, global winds would blow due north or south. But Earth's rotation helps to cause global winds to curve.

The Earth is composed of several

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parts. The *lithosphere*, consisting mainly of the rigid, rocky crust of the Earth, extends to depths of 100 km (60 mi). The thinnest part of the Earth is the *crust*, a layer of solid rock and dirt. That is the surface of the Earth and the part we see. The *mantle* and *core* are the heavy interior of the Earth, comprising most of its mass. The lithosphere contains the crust plus the upper shell of the mantle. The lower mantle is thought to be made of molten rock. Beneath the mantle is Earth's core, believed to be made mostly of nickel and iron. The inner part of the core is solid, but the outer part is liquid. Temperatures in the inner core may be as high as 6,650ºC (12,000ºF). Fortunately, temperature ranges on Earth's surface are not even close to the temperatures of its core. In the deserts of Libya in Northern Africa, temperatures have been recorded as high as 58°C (136ºF), and at the South Pole, as low as a ⁻89.6ºC (⁻128ºF).



Above Earth's solid surface lies its atmosphere containing the perfect mixture of 78% nitrogen, 21% oxygen, and smaller amounts of other gases, allowing us to breathe comfortably. Even the slightest change in these percentages would cause life on Earth to perish.

Scientists look for evidence to determine whether a theory is true or not. Much evidence exists to verify the Anthropic Principle: the division between day and night, the precise positions of the Sun, Moon and stars, global winds and the perfect mixture of atmospheric gases.

You took a deep breath as you started the final soccer practice before the game. The temperature was a perfect 72° Fahrenheit. The skies were clear. It was a beautiful sunny day. Those wings must have still been on your feet, because you were faster than ever. The daily evening runs had really built up your endurance. You had increased the jogging distance because longer runs seemed easier for you. Your daily runs took you past Michael's house, around LaToya's house and on to another block. As you thought of Michael, you suddenly were aware that he was on the sidelines. He had never come to one of your practices before. His presence startled you.

Life Principle



"Nature is the art of God."

—Dante

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Lesson 6
Biology

Chapter 4

Theories of Origin, Scientific Laws

Section 2

Lessons 6-10

LIFE ON EARTH





Michael rode his bike to your soccer practice to let you know that his dog, Candy, was about to give birth to a litter of puppies. Candy was a Black Labrador Retriever and was the mother of your dog, Princess. This would be Candy's third and last litter because Michael's parents planned to have Candy *spayed* before she came into heat again. When Princess was about three weeks old, you noticed how cute and playful she was and asked your parents if you could have her. Michael gave her to you when she was eight weeks old and fully *weaned*. You and Princess had been inseparable since then. You did not want another puppy, but you were curious about the birth process. Michael told you to hurry over as soon as soccer practice was finished.

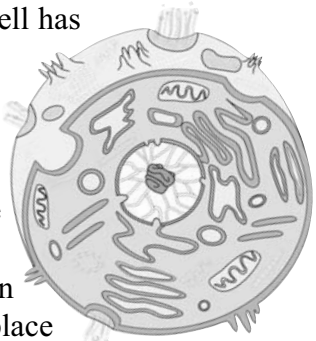
When you arrived, Michael's mom escorted you to the laundry room where Candy was in a big box. The first puppy had already been delivered, and Candy was licking the puppy clean. Michael had already named the puppy "Uno," which is Spanish for number one. Uno's eyes were not open, and he was squirming as Candy licked him. He was tiny. Candy was a big dog, weighing about 60 pounds when she was not pregnant. Yet, she was so gentle as she cleaned Uno. While you watched, five more puppies were born. You were amazed to see their little wriggling bodies respond to their mother's touch. Soon, all six began to nurse. The entire process was fascinating and seemed wonderfully designed. Candy and her puppies seemed instinctively to know just what to do. All you, Michael and Mrs. Rollins had to do was observe. Candy did all the natural things mothers do at the birth of their offspring.

VOCABULARY

Spayed: to remove the reproductive organs of a female animal
Weaned: to accustom the young of a mammal to take nourishment other than by suckling
Complex: intricate or complicated
Protein: any of a group of complex amino acids that occur in all living cells and are essential for growth and repair of the cell and tissue
Molecules: the smallest particles into which an element or compound can be divided without changing its chemical and physical properties

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Life is ***complex*** even to the single cell, the basic building block of all living things. A single cell has the capacity to produce thousands of different ***proteins*** and other ***molecules***, at different times and under variable conditions. Growth, repair and communication are functions that take place in every cell. Each of Candy's puppies was made of billions of cells, all working together to function as a living, breathing, moving, intelligent form of life. Candy's owner, Michael, like other teenagers, was composed of trillions of cells. Each of Michael's cells was also an ***irreducibly*** complex system, one that required many interacting parts to function. If a part was removed or destroyed, then the function was also destroyed.



single cell

VOCABULARY

Irreducibly: impossible to reduce to a simpler form
Integral: necessary
Empirical data: observable data
Hypothesis: educated guess (plural is *hypotheses*)
Reproduction: process by which organisms produce more of their own kind
Natural selection: organisms retain favorable characteristics and transmit them to offspring while rejecting unfavorable or injurious variations
Genes: heredity information passed from parent to offspring
Entropy: a measure of disorder or disorganization
Disarray: a state of disorder
Refute: to prove to be false or erroneous

Think of the lock on your front door. If the door is locked, it will not open. If you insert the wrong key, the door will not open. You have to insert the correct key, turn the knob in conjunction with turning the key and push in the right direction for the door to open. Cells are incredibly more complex than operating a front door. One function of a cell is to produce protein, essential for growth and repair of tissues. A protein has to move from where it is made to where it is designed to be used. In the moving process within the cell, the compartment that holds the protein has a wall equipped with something like a closed door. If a protein bearing the right "key" approaches, the "door" opens and allows the protein to pass through. If a protein with the wrong "key" approaches the door, the protein cannot complete its journey. Such complexity is not limited to protein transportation within the cell, but is an ***integral*** part of all life. In multi-cell organisms, cells form to make tissues. Tissues form to make systems. Systems connect to make awesomely complex living organisms. Candy and her puppies were just one type of living organism out of the many billions that occupy Earth's surface.

You jogged home after a couple of hours at Michael's house watching Candy and her puppies. As you opened the gate to your backyard, Princess greeted you with one of her "happy" barks and a wagging tail. You petted her and hugged her with even more enthusiasm than usual, after seeing the miracle of birth. You wished you could have seen Princess born. Now, you understood her growth and development more than ever before because you had witnessed the birth process. You appreciated the care Candy must have taken with Princess during her first eight weeks after birth, before you brought her home. You looked at the almost fully-grown Princess and could hardly believe

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that at one time, she would have fit in your hand. Uno and the other puppies were the evidence of how small Princess used to be.

Even if you had missed Uno's birth, you would have had evidence available to let you know what Princess was like as a newborn. Puppies are born every day. You knew that Princess was a breed of dog called a Black Labrador Retriever. You probably could have found a litter of newborn Black Labrador Retrievers somewhere in your town in order to observe birth and growth processes. You expanded your thoughts to consider the origin of life on Earth. You wondered about evidence to support how life began.

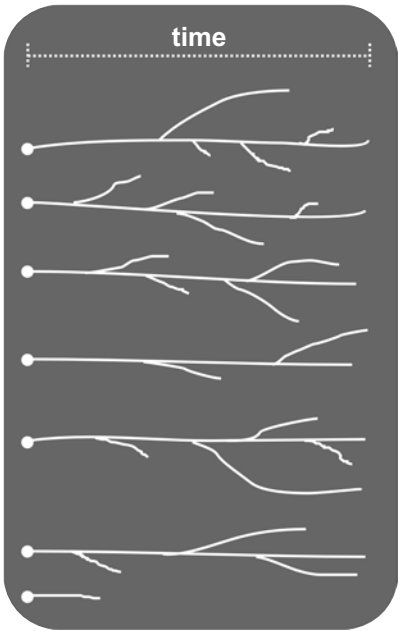
When scientists use information to solve a problem, they look for ***empirical data*** to support or reject whatever ***hypothesis*** they have formulated. Empirical data is actual data that scientists can observe. Then scientists test their *hypotheses*, analyze the data, and form conclusions.

To answer the question about how life began, scientists must look at life as it currently exists. Candy gave birth to puppies. A cow gives birth to a calf. A cat gives birth to a kitten. If a farmer wants to produce pigs, he breeds pigs. If he wants to grow watermelons, he plants watermelon seeds. If you want to grow sunflowers in your garden, you plant sunflower seeds. The scientific word for this is ***reproduction***, the process by which organisms produce more of their own kind. Living things produce offspring that are like themselves. Reproduction is the life process that ensures that any kind of living thing will continue to exist. All living organisms reproduce after their own kinds to replenish the Earth with life.

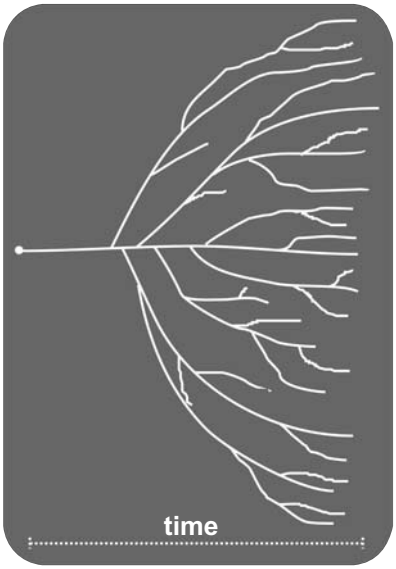
Scientists have developed two main theories of how life could have started on Earth. One theory is that life exists by plan and purpose.

Plan and Purpose

Variations occurred over time within the originally designed basic species.



The other theory is by chance or accident, referred to as the *Theory of Evolution*.



Theory of Evolution and Natural Selection

All current species are descended from one common ancestor, which evolved from non-living chemicals.

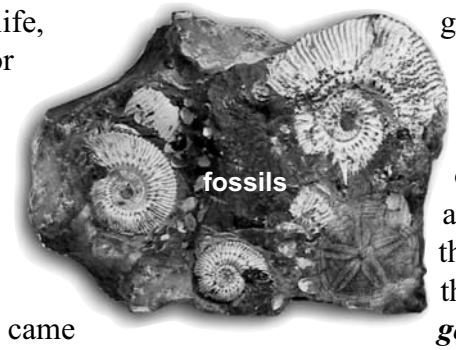
Life on Earth began either wholly complete consisting of simple and complex organisms, or it began with a series of random, accidental

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happenings over time, by which simple organisms became complex organisms by chance. These theories are mutually exclusive. Only one or the other can be true.

Many sub-theories of evolution exist. The concept of organic evolution (pertaining to living things) was popularized by British naturalist, Charles Darwin, in *On the Origin of Species* and other books he published in 1859-1871. His last book promoted the idea that man had descended from ape-like creatures. Darwin presented observations about finches and other creatures, which led many scientists and agnostics of his day to embrace the idea of ***natural selection***. Darwin and his followers supposed that man had evolved from lower forms of life which Darwin predicted the fossil record would reveal. The basic Theory of Evolution supposes the existence of many intermediate forms of life, linking together various major kinds. However, the absence of fossil evidence has been a persistent problem to evolutionists from Darwin to the present. Even so, the Theory of Evolution was popularized in textbooks and came to be taught as fact; although after more than 140 years, the theory remains without positive proof. The fossil record shows that animals appeared as fully formed species, without transitional forms. When scientific methods are used, theories can become scientific law, like the Law of Gravity. Some scientific laws, such as the Laws of Heredity, had not been published in Darwin's time. Therefore, his views were accepted as fact by many scientists. As more knowledge became available, other scientists on a quest for truth challenged Darwinian ideas of *macro-evolution*, the concept that one life form (such as reptiles) evolved into another life form (such as birds) over millions of years. To many scientists, evolution seems to be a philosophy or belief system to be defended, rather than a theory to be proved or disproved objectively. Today, the discovery of DNA has caused an increasing number of modern scientists to question the validity of Darwin's theory about the origin of species.



Scientific information is accepted universally as a law when data has been proven over time to be true, and no exceptions have been found. Scientists then base further research on the law that is considered to be a true or absolute. The Laws of Heredity show us that living things reproduce, with amazing accuracy, offspring that are like their own kind. This means that a dog will always give birth to a puppy, never to a kitten. While genetic variations exist among members of a particular group, instinctive limits are established as to how much change takes place. The Laws of Heredity tell us that the offspring of two dogs will always be puppies, and that they will be a combination of the mother's and the father's ***genes***.

The Law of Biogenesis states that every living thing must come from some other living thing. Life cannot come from non-life. Each offspring can be traced to its parents. Some single-celled organisms, such as bacteria, can duplicate themselves through asexual reproduction. But even then, the parent is the original cell. No matter how microscopic the organism, it can always be traced to its parent(s). No life ever spontaneously generates on its own, according to the Law of Biogenesis. Michael knew that Candy was going to have puppies. His family planned for that event by mating Candy with a male Black Labrador Retriever. No female dog ever became pregnant without having gone through the

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mating process with a male dog. Offspring do not just appear. They can always be traced to parents. That is an absolute truth, which allows predictability that offspring of like kind will be the result of a male and female uniting in the act of reproduction.

The Law of Biogenesis and the Laws of Heredity give evidence of a universal design that established life. Evidence from the present, as well as evidence from the past supports these two basic laws. Scientists study fossils to form ideas about life in the past. If the theory that life as we know it evolved accidentally over time from the simple to the complex, then the fossil record should show the skeletons of plants and animals that are in the process of gradual change. In other words, millions, even billions, of fossils that are part of one thing and part of another should be evident. But that is not what the evidence shows. Fossil evidence shows that species changed very little in appearance throughout time. Humans may be taller and stronger now, but their skeletons have always been fully human. The theory that life evolved by chance is not supported by the Laws of Biogenesis and Heredity, nor the fossil record.

The Second Law of Thermodynamics, also called the Law of ***Entropy***, states that all systems move naturally from an ordered state to a disordered one; that everything will decay,



decompose, wear out, or run down. This is evident as we observe the world around us. If Michael were to leave his bicycle outside for any length of time, the bicycle would rust, the tires would go flat, and the paint would chip and flake. Over time, things do not improve on their own. Even if you clean your room and do not enter it for a week, you will not find it any better when you return. In fact, it will be worse. You will have a week's worth of dust settled everywhere, and you may even discover papers in ***disarray*** on the floor, blown there by wind from your hurried exit. The Second Law of Thermodynamics supports the theory that life began in a highly organized state. For life to go from something simple, and by chance produce something amazingly complex, would be an exception to this universal law. The probability of life evolving is comparable with an explosion in a print shop producing a dictionary, or a whirlwind in an automobile factory assembling a Cadillac. The Theory of Evolution is in direct opposition to the Second Law of Thermodynamics. Evolution suggests that useful traits can just appear, be preserved by the organism, and be passed on to succeeding generations, while harmful traits are eliminated.

Empirical data strongly suggests that life began with basic, complete, complex organisms and produced many different varieties of those life forms. Lack of transitional fossils and the clear violation of many of the laws of science ***refute*** evolution as fact. It must remain a theory, just as all theories about the origin of life (from a scientific perspective). The non-repeatable, unobservable past is not subject to the scientific method for establishing proofs of theories.

Looking at Princess, you could see many of Candy's features: the long tail, the broad face and nose, and the short black hair. You thought Princess was a very special design, and from the way she wagged her tail, Princess must have felt the same about you.

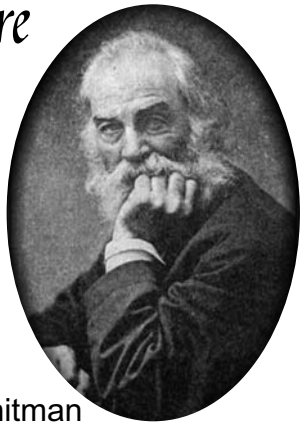
After dinner, you jogged back over to Michael's for one last look at Uno and the other

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puppies. They were fast asleep, snuggled warmly up against Candy. Michael offered to show you something on his dad's computer. Using a password, Michael logged on to the Internet and took you to a website on Labrador Retrievers. You were so involved in looking at the pictures and reading about this breed of dog that you didn't hear Mr. Rollins enter the room. He appeared disturbed that you and Michael were using the computer and asked Michael to log off. You took one last look at Candy and her sleeping puppies before jogging home.

Life Principle

"Seeing, hearing, feeling are miracles, and each part and tag of me is a miracle."



—Walt Whitman

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Lesson 7
Astronomy

Chapter 4

Composition, Characteristics, Comparisons and Conjectures

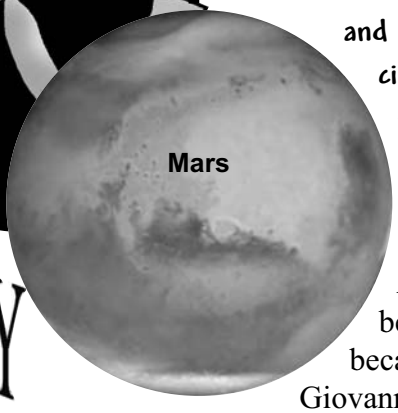
Section 2

Lessons 6-10

MARS



You had trouble falling asleep. Mr. Rollins seemed very disgruntled that you and Michael were using the computer. Perhaps he was just concerned about his computer programs being wiped out by a virus and not really mad at you or Michael. He had always been courteous to you in the past, so you assumed that things had not changed. He must have been under a lot of pressure from his work and recent computer problems. Sometimes circumstances in life are not as they seem, so we need not worry about something that may or may not exist.



As scientists study space, things are not always as they seem, either. Astronomers in previous centuries believed that life existed on Mars because of what men thought they saw. Giovanni Schiaparelli and others in the middle and late 19th century believed they saw seasonal color changes that indicated a green springtime on Mars. Some astronomers interpreted other sights such as the lines on the surface of Mars to conclude "canals" were built to channel water across the desert-like planet. Actually, later observations proved these lines to be streaks of dust, which occasionally change their shape due to windstorms. An ***optical illusion*** makes them look like canals. American astronomer Percival Lowell believed so strongly in the existence of an advanced civilization on Mars that he wrote several books on the subject in the early 20th century. He proposed that the canals carried water from the wet Polar Regions to the dry equatorial deserts. British futuristic fiction author, H. G. Wells, and American author, Edgar Rice Burroughs (creator of Tarzan), were greatly

VOCABULARY

Optical illusion: a deceptive visual image
Organic: derived from living things
Metabolism: the physical and chemical processes occurring within a living cell or organism that are necessary for life
Vaporizes: to be converted into vapor
Iron oxide: compound formed when iron combines with oxygen
Retrograde revolution: moving around a thing "backwards"; counterclockwise revolution

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influenced by Lowell's beliefs, to the extent that some of their writings contained themes based on Martian life. Careful study of empirical data led astronomers to disregard false conclusions drawn by Lowell, Wells and Rice. These noted writers were sincerely wrong about Mars.

For centuries, some scientists who believed in evolution speculated about the possibility of life on Mars. Early astronomers detected both bright and dark areas as well as whitish caps covering the poles. Some scientists suggested that the bright areas on Mars were land patches and the dark areas were seas.

Skeptical scientists wanted answers to these hypotheses about life on Mars. Exploration of Mars began by both the Soviet Union and the United States in the 1960s. Pictures from the *Mariner* spacecraft, launched by the United States in the 1960s, showed impact craters on Mars like those on Earth's Moon. However, the photographs did not reveal any evidence of the advanced civilizations that people in the 19th century imagined might exist on Mars. The Soviet Union had difficulty with their missions to Mars. The first probe crashed while landing in 1971. The next two probes failed to send back more than a few seconds' worth of data. The United States sent two probes, *Viking 1* and *Viking 2*. Both landed on Mars in 1976 and sent back detailed information. One part of the Viking mission was to search for evidence of life. One instrument was designed to detect ***organic*** molecules in the soil. No evidence of organic molecules was found. Three biological experiments tested soil samples for evidence of ***metabolism***, growth or *photosynthesis*, the process by which plants make food. None of these experiments showed evidence to substantiate the presence of life.

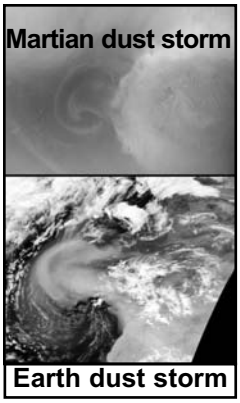
Although the surface of Mars, is more like the surface of Earth than any other planet, Mars would be a harsh place for humans. The temperature on Mars does not get much colder than the temperature at Antarctica, the most frigid place on Earth. The northern polar ice cap on Mars is made up of frozen water and carbon dioxide. During Martian summers, the carbon dioxide ***vaporizes***, and the size of the polar cap decreases considerably. The southern polar cap of Mars changes little throughout the Martian year. Actual temperatures on Mars range from a high of about $^{-}20^{o}C$ to a low of $^{-}140^{o}C$.

Mars is the fourth planet from the Sun and has a diameter of 6,788 kilometers. Mars is smaller and colder than Earth. Mars is tilted on its axis at 25 degrees compared to Earth's tilt of 23 1/2 degrees. The 25 degree tilt gives Mars four seasons, just as Earth's tilt gives it four seasons. But at 687 days, Mars' year is longer, so its seasons are longer, too.

Earth/Mars Comparison

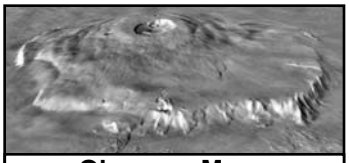
	Earth	Mars
Diameter	12,756 km	6,788 km
Period of rotation	23 hrs. 56 min	24 hrs. 37 min
Period of revolution	365.25 days	686.98 days
Tilt	23.5 degrees	25 degrees
Number of Moons	1	2

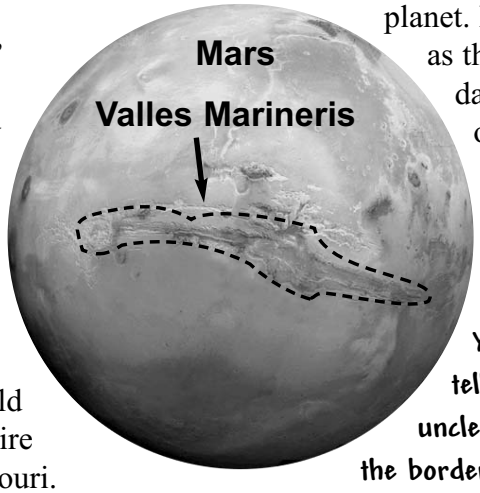
Earth's seasons last about three months. Those on Mars last six months. At certain times of the Martian year great dust storms appear as yellow clouds, usually during the southern Martian spring and summer when Mars is closest to the Sun. Some of these storms can last for months. The Hubble telescope has provided images of dust storms. The dust is not sandy, as in a sandstorm on the Earth, but has the consistency of flour.



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Pictures from the *Viking* probes reveal that Mars looks like a desert with scars on its surface carved by wind, craters, and volcanoes. *Valles Marineris* is Mars' largest canyon. If placed on Earth, this canyon would stretch from New York City to Los Angeles. That is much larger than Earth's Grand Canyon. *Olympus Mons*, located on Mars, may be the largest known volcano in the solar system. The base of this volcano would cover the entire state of Missouri. Mars is named for the Roman god of war and is called "the red planet," because it appears fiery red in the Earth's night sky. The distinct red color of Mars is visible from Earth even without a telescope. This color comes from ***iron oxide*** in rocks on the surface of Mars.


Olympus Mons



Mars has two small moons, *Phobos* and *Deimos*, named after the dogs of the Roman god, Mars. Phobos is about 27 km in diameter and has a ***retrograde revolution*** which means it appears to rise in the west and set in the east. Most orbiting bodies appear to rise in the east and set in the west. Phobos orbits Mars several times in one Martian day. Deimos is about 15 km in diameter and takes over 30 hours to complete its orbit.

The atmosphere of Mars is 95 percent carbon dioxide, nearly 3 percent nitrogen, and nearly 2 percent other gases. The Earth's atmosphere is mostly nitrogen and oxygen. Mars has a few thin clouds in its sky. Mars' atmosphere lacks ozone. As a result, harmful ultraviolet rays from the Sun penetrate the atmosphere and reach the surface of the planet.

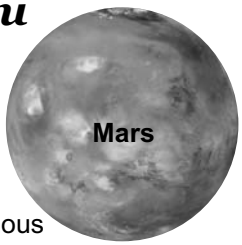
When early astronomers hypothesized that life existed on Mars, they had no way of knowing how harmful the atmosphere would be for organic molecules. For centuries, scientists speculated that life might be discovered on our neighboring planet. But things were not as they seemed. Current data indicates that life on Mars does not exist.

As you were about to drift to sleep, the phone rang. You heard your mom tell your dad that Maria's uncle had been detained at the border. Maria's mom was really upset and was asking your dad to make some calls to the Customs officials to see what could be learned about the situation. Your dad was a truck inspector for the highway department. He worked with weight limits and load limits on commercial transportation vehicles. He had connections with the border Customs office. You sincerely hoped this delay would not distract Maria from attending the soccer game. You were confident things could be worked out; but you also knew that things were not always as they seemed!

Life Principle

" Being sincere isn't enough—you can be sincerely wrong."

—Anonymous



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Lesson 8
Physics

Chapter 4

Gravity, Velocity, Friction

Section 2

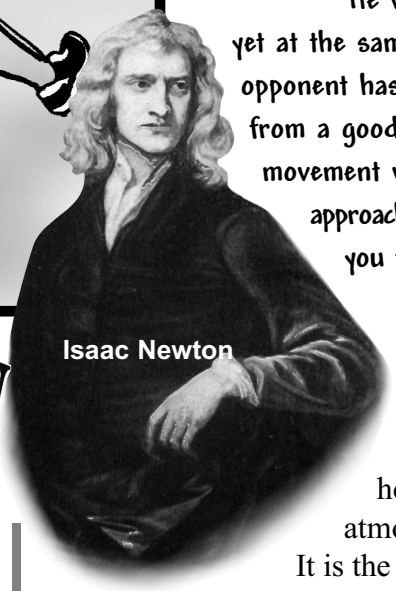
Lessons 6-10

EVERYTHING IS MOVING



Maria and her dad picked you up before the game so you would have plenty of time to warm up. Maria's family was worried about her uncle. You tried to assure them that your dad would find out the nature of the problem and help correct it. Maria's dad agreed. He wanted you and Maria to concentrate on playing your best during the game.

He wanted you to keep the ball in motion yet at the same time, keep it under control. An opponent has difficulty stripping a moving ball away from a good soccer player. A controlled pattern of movement with a burst of *acceleration* as you approached the goal was what the coach wanted you to focus on during the game.



Isaac Newton

The solar system operates under a similar system. Everything in space is moving in a controlled manner, working within the gravitational forces exerted on objects. ***Gravity*** holds the planets together and their atmospheres in place. Gravity is a force. It is the force that attracts objects towards one another. On Earth, gravity pulls objects downward. Without gravity, everything would float away from Earth into space.

Gravity, mass and distance are closely linked. *Mass* is the measure of how much matter is in a body. Isaac Newton stated that the pull of gravity depends on more than just the masses of two objects. Gravity also depends on the distance between the objects. Study the table on the following page to compare mass, density and surface gravity of the planets. Notice that the five planets furthest from the Sun are less dense than the terrestrial planets. That is because those five

VOCABULARY

Acceleration: increase in speed
Gravity: the force of attraction between any two objects
Gravitational attraction: the pulling between two objects due to gravity
Velocity: the rate per unit of time at which a body moves in a specified direction; speed
Constant: unchanging; does not vary
Friction: a force that results from the interaction between two surfaces

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planets are composed mainly of gas, which is less dense than the solid rock and dirt composition of the terrestrial planets.

Mass/Density/Surface Gravity Comparison of Planets

Planet	mass compared to Earth	density (g/cm^3)	surface gravity
Mercury	0.06	5.42	0.38
Venus	0.82	5.24	0.90
Earth	1.00	5.50	1.00
Mars	0.11	3.94	0.38
Jupiter	317.83	1.31	2.53
Saturn	95.15	0.70	1.07
Uranus	14.54	1.30	0.92
Neptune	17.23	1.66	1.12
Pluto (dwarf planet)	0.002	2.03	0.06

Every object in the universe pulls on every other object. This pulling is called ***gravitational attraction***. Neighboring objects in space do not collide because their attractions are balanced. They are spaced in such a way that each one pulls on the other with an equal force. Because of this, they stay at an established distance from one another.

Gravity is the force that keeps the planets in their orbits around the Sun. Gravity is the force that keeps the Moon in its orbit around the Earth. Early in history, people could predict the paths of the stars in the sky. Not until the 1500s and the 1600s were scientists such as Copernicus, Galileo, and Newton able to understand what made such movements regular and predictable.

VOCABULARY

Inertia: the tendency of a body to remain at rest or stay in motion unless acted upon by an outside force

Relative motion: the change in position of one object compared to the position of another object

According to an old story, Isaac Newton learned about gravity while watching an apple fall from a tree. Actually, people knew about gravity before Newton's time. But Newton was the man who formulated the Law of Gravity and stated that gravity exists throughout the universe and applies to planets, stars, and other objects.

In addition to his theory about gravity, Newton proposed three laws to explain the behavior of moving objects. His laws combined the findings of Galileo, Kepler, and other scientists with his own observations and helped build the foundation of modern science.

Newton's First Law of Motion states that all objects resist changes in motion. That is why Maria's dad wanted you to keep the soccer ball in motion. He knew that a soccer ball lying in the grass is an object at rest. The ball has zero ***velocity*** because it is not moving. The ball will not begin to move, or change velocity, by itself. It will remain at rest until a force causes it to move. If you keep the ball moving, a defender will have difficulty stripping the ball from you.

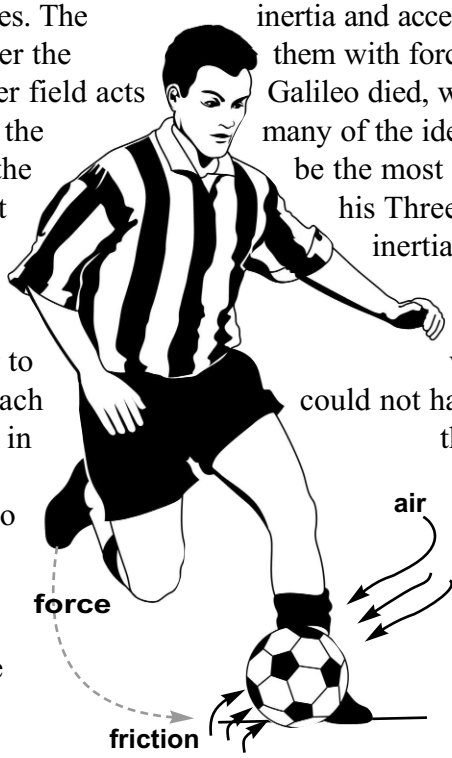
Remember that a force is a push or a pull. When you kick a soccer ball, you apply a force to the ball. You "push" the ball in the direction of the kick. The First Law of Motion also explains that an object moving at a ***constant*** velocity in a straight line tends to continue in the same straight line. If you apply a force to the moving object, the velocity of the object will change, which means that speed or direction or both will change.

A good soccer player will keep the ball moving in the direction of the goal. Hopefully, he will apply a powerful kick (a force) as he

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gets close to the goal to accelerate the speed of the ball, and thereby score.

Some other force could, however, prevent that ball from reaching the goal. Newton's first law establishes that the ball will continue in a straight line unless acted upon by another force. That other force could be a defender from the other team who anticipates the path of the ball and kicks it away. Or the other force could be friction. ***Friction*** is the force that results from the interaction between two surfaces. The rougher the surfaces, the greater the friction. The grass of the soccer field acts as an agent of friction to slow the speed of the ball. That's why the force of a kick on the ball as it approaches the goal needs to be powerful enough to overcome the force of friction and the ability of the defender to reach it. Jogging three miles each evening gave you the strength in your legs to apply a strong enough force to kick the ball to make it travel a great distance at a fast speed.



Newton's Laws of Motion help us understand the movement of a soccer ball as well as the movement of the heavenly bodies in the universe. Every heavenly body is moving, and each one keeps on moving. The Moon moves around the Earth. The Earth and the other planets move around the Sun. The Sun itself is moving. So are the stars and the galaxies.

The movement of the heavenly bodies can be explained by what scientists call ***inertia***. The Law of Inertia states that: (1) A body that is at rest (not moving) will stay at rest unless some force acts upon it. (2) A body that is moving will keep moving unless some force acts upon it.

On Earth, air resistance and gravity slow down moving objects. But air does not exist in outer space, and the gravitational attraction between all heavenly bodies is balanced. Very little friction operates to slow or stop objects in space. They just keep moving.

Galileo Galilei lived from 1564 until 1642. His studies of falling objects, motion on an inclined plane, and projectile motion all helped provide a better understanding of motion. His writings indicated that he understood about inertia and acceleration, but he did not connect them with force. Newton, born in the year Galileo died, was the one who tied together many of the ideas of motion. Considered to be the most important scientist of all time, his Three Laws of Motion include inertia, acceleration, and forces. Newton gave credit to Galileo by saying that without the work of Galileo and others, he could not have accomplished so much in the field of science.

Everything in the universe is moving. You cannot distinguish that the Earth moves through space because you move right along with the Earth. Motion is very noticeable if you are standing still and another object is moving. You easily see the other players on the soccer field move past you if you are sitting on the sideline. ***Relative motion*** is the change in position of one object compared to the position of another object. Since you, the Earth, and everything on the Earth are moving, you do not notice that you are spinning through space at an average orbital speed of 29.79 km/s.

Your team was doing well. The game was almost over and the score tied at three goals each. You did start at right forward. Maria, started at center forward, and scored two of the

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three goals. LaToya, playing a mid-field position, scored the other one. The ball came towards you with just a few seconds left in the game. Your endurance had strengthened because of your workouts. Your skills had improved because of your commitment to work on the fundamentals of the game. You remembered what Maria's dad said, and you kept the ball under control as you constantly moved toward the goal. With a swift, powerful kick, you exerted enough force on the ball to send it accelerating toward the goal. The goalie could not reach the ball, so you scored the winning goal!

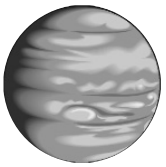
Life Principle

"If I have seen farther than others, it is by standing upon the shoulders of giants."



—Isaac Newton

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Lesson 9
Astronomy

Chapter 4

Composition, Characteristics and Comparisons

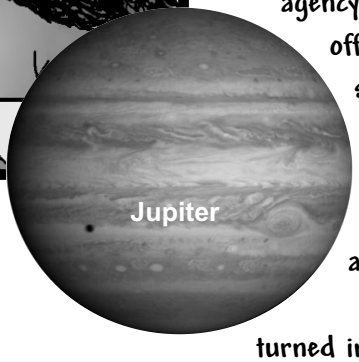
Section 2

Lessons 6-10

JUPITER



Everybody rushed over to congratulate you! You felt good to realize that you had made a significant contribution to the team's first win. The team and their families celebrated by stopping by the mall for ice cream. Maria's parents took the opportunity to talk with your parents about the problem with the border patrol. Your dad had found out that a government agency had instructed the Customs officials to detain Maria's uncle until some type of security clearance could be issued. Once that was done, Maria's family was allowed to continue their trip. They planned to arrive the next day.



Princess wagged her tail as you turned in the driveway. She was always glad to see you. After you rested awhile, you put the leash on Princess and rode your bike over to Michael's house to see Candy and her puppies. Mr. Rollins was putting out fresh water and food for Candy when you arrived. Because he considered Candy as his dog, Mr. Rollins took special care of her. Mr. Rollins wanted a good dog for duck hunting, so he trained her and took her with him to a cabin on a lake each year during duck season. Candy responded well to Mr. Rollins' whistle and verbal commands. He even trained her to respond to some hand signals. These puppies represented Candy's third litter. Mr. Rollins already had a waiting list of people who wanted the puppies. When you arrived, Mr. Rollins patted Princess on the head and remarked that you should start training her, then commented on the similarities between Princess and her mother, Candy.

VOCABULARY

Satellites: celestial bodies that orbit planets; moons
Ammonia: a colorless gas composed of nitrogen and hydrogen
Methane: an odorless, colorless, flammable gas composed of carbon and hydrogen
Fusion: a nuclear reaction in which nuclei release energy when combining to form more massive nuclei
Impurities: not pure; mixed with other substances

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You were glad to see Mr. Rollins in such a good mood. He seemed more relaxed than you had seen him in the last few days. He and Michael let you hold the puppies. Differences were already evident in them. One was larger and fatter than the others, and one was much smaller. The smallest one was called the "runt" of the litter. Some puppies were clumsily bounding around in the pen Mr. Rollins had built. Others were napping. All seemed to be doing fine.

Although many similarities exist among the planets, great differences also exist among them. They are similar in that they all rotate on an axis as they revolve around the Sun in elliptical orbits. They all are held together by gravity and most of them have ***satellites***, called moons. Differences also exist, especially among the first four planets as compared to the last four planets. The first four in order from the Sun (Mercury, Venus, Earth, Mars) are called *terrestrial* planets because they are composed mainly of solid rock and soil. They are Earth-like in their compositions. The next four—Jupiter, Saturn, Uranus and Neptune—are called the gaseous giants because they are composed mainly of gases. The dwarf planet, Pluto, is furthest from the Sun, and is so unlike either of the two groups that it is not considered a planet.

VOCABULARY

Ultraviolet: a range of invisible radiation wavelengths
Violet light: the short-wave end of the visible spectrum
Renaissance: a period of time, roughly the 14th through the 16th century, in which many scientific discoveries were made

Jupiter, the fifth planet from the Sun, is the largest planet in our solar system. It's mass is 318 times Earth's mass. In fact, Jupiter is one and a half times larger than all the other planets put together and contains more than twice their total mass. Jupiter's year, or the time required to complete an orbit around the Sun, is 11.9 Earth years. Jupiter's day, or the time required to rotate on its axis, is about 9.9 hours, less than half an Earth day.

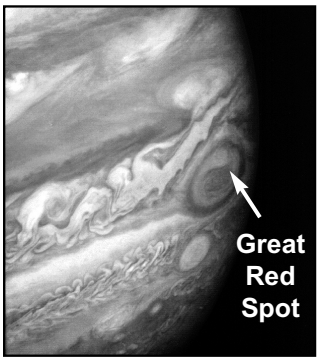
Earth/Jupiter Comparisons

	Earth	Jupiter
Diameter	12,756 km	142,796 km
Period of rotation	23 hrs 56 min	9 hrs. 55 min.
Period of revolution	365.26 days	11.86 years
Average orbital speed	29.79 km/s	13.06 km/s

Jupiter is composed mainly of gaseous and liquid hydrogen and helium, with smaller amounts of ***ammonia***, ***methane***, and water vapor. Jupiter has a relatively small core of molten rock and iron, but no solid surfaces. Although Jupiter and the Sun are made of much of the same material, the pressure and temperature at Jupiter's core are too low to cause the ***fusion*** of hydrogen, which is the requirement for a body to become a star.

The only part of Jupiter that has been seen is its outer covering of clouds. Rising air masses in Jupiter's atmosphere expand north and south. When these bands of air meet the air that circulates from the equator of Jupiter, a striping effect is formed. The clouds form bands of different colors, making Jupiter look like it has red, white, tan and brown stripes. Within these clouds are continuous storms of swirling gas. The Great Red Spot of Jupiter is a storm, which was first seen through a telescope in 1664. The atmospheric storm, larger than the entire planet Earth, has been raging for at least 300 years. The red

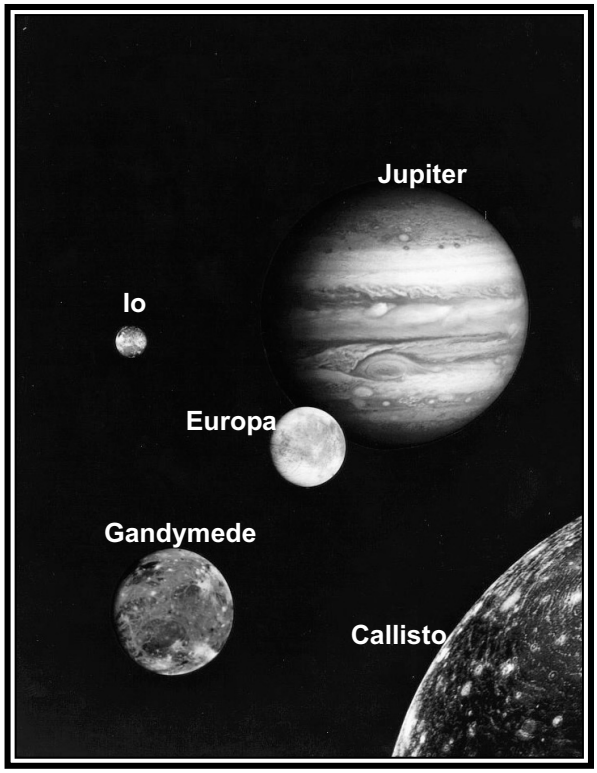
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color of the spot appears to be caused by ***impurities*** that absorb ***ultraviolet*** and ***violet light***.

Italian scientist Galileo Galilei, (1564-1642), the Father of Modern Science, was the first man to view Jupiter through a telescope in 1610. Galileo observed four satellites, or moons, in orbit around Jupiter. Regarding this discovery, he wrote, "I give thanks to God, who has been pleased to make me the first observer of marvelous things unrevealed to bygone ages. . . . But the greatest marvel of all is the discovery of four new (moons of Jupiter) . . . . that (with Jupiter) move around the Sun." Galileo's discoveries and thinking was heavily influenced by the writings of Nicolaus Copernicus, Founder of Modern Astronomy, who developed the theory that the Earth orbits the Sun. Before 1610, men believed that the Sun orbited Earth. Copernicus (1473-1543) believed that the Sun, and not the Earth, was at the center of the solar system. The view by Copernicus, was a key element of the ***Renaissance*** and the Age of Enlightenment. Astronomers later proved that Copernicus was correct. Astronomers also proved that sixteen moons revolve around Jupiter. The first four moons to be discovered, *Io*, *Europa*, *Ganymede*, and *Callisto*, are called the *Galilean moons* in honor of their discoverer, Galileo Galilei.

Io and Europa are each about the size of Earth's Moon while Ganymede and Callisto are larger. Ganymede is the largest satellite in the solar system. It is larger than the planet Mercury. Io is the most famous Galilean satellite because it has active volcanoes on its surface. Sulfur lava gives it a distinctive red and orange color.



Much of what we know about Jupiter comes from the *Voyager* probes, launched by NASA in 1979. The visual images provided detailed maps of Jupiter's cloud deck, the upper atmosphere, the magnetic field and its moons. We know that Jupiter is encircled by a series of thin rings. *Voyager 1* obtained images of a ring of rocks and boulders that are concentrated in the equatorial plane of Jupiter. Not much is known about this ring. It has no well-defined inner boundary, but a sharply defined outer edge.

Much is still to be learned about Jupiter. More data was sent from a remote probe launched from the spacecraft *Galileo*. The probe reached Jupiter in 1995 and transmitted data until the probe reached a depth in Jupiter's atmosphere, at which point high temperatures caused the transmitter to fail.

Mr. Rollins told you much is to be learned about dog training. He offered his computer to you and Michael to find a website with information about how to start training a puppy. After Mr.

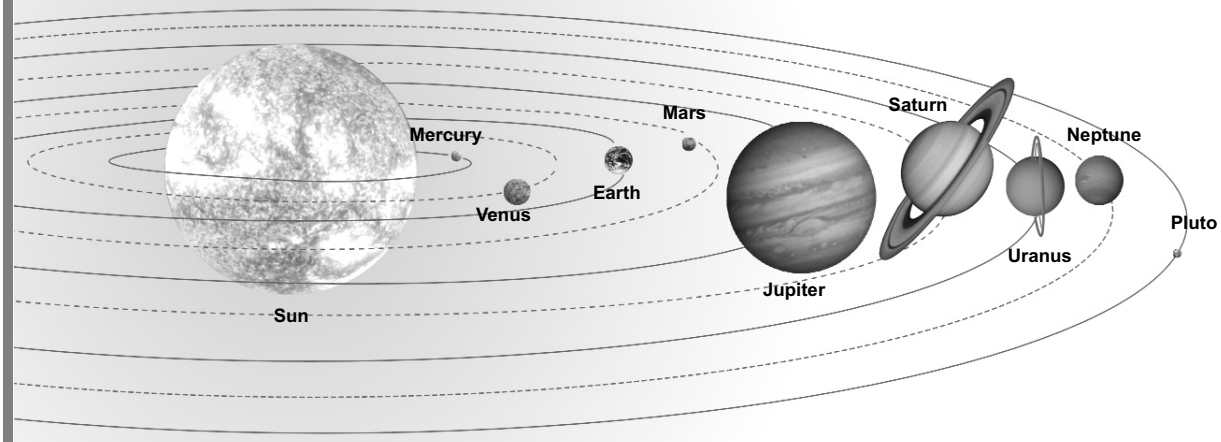
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Rollins typed in a password, he navigated the Internet until he reached the website he wanted, which was filled with information and good advice. Mr. Rollins brought in a few of the puppies to hold in his lap while you and Michael explored other links about dogs. The Sun was causing a glare on the screen so you crossed the room to lower the blinds. As you did so, you could not help but notice a van parked out in front of Michael's house. The van looked familiar, but you could not remember where you had first seen it. You closed the blinds and returned to the computer.

Life Principle

"Every cubic inch of space is a miracle."

—Walt Whitman



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Lesson 10
Astronomy

Chapter 4

Composition, Characteristics and Comparisons

Section 2

Lessons 6-10

SATURN



The ringing sound awakened you. You could not immediately determine whether the doorbell or the phone was ringing because you were still half asleep. The excitement of winning the soccer game finally took its toll on you, and that night you fell into bed, exhausted. You slept longer than usual the following morning. You heard your mom having a one-way conversation, so you knew the ringing must have been from the phone. Apparently, the caller was Maria's mother who was reporting that their family from Mexico, the Medranos, had arrived while you slept. The soccer party was on schedule for the coming evening.

The occasion was to be special, certainly ***unique***. You anticipated playing your own team, much like when you divided up for practice. However, the four additional players from Mexico were expected to add enthusiasm to the game. Afterward, everyone was to have an opportunity to do some stargazing through Mr. Medrano's telescope.

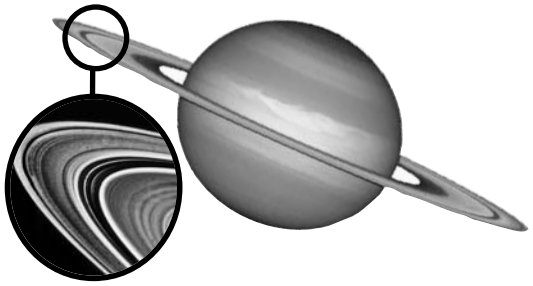
Saturn is unique among the planets because of its rings. Astronomers have not been able to determine why the rings are there or what purpose they serve, but they are clearly evident. Galileo was the first man to discover these rings in 1610, using one of the first telescopes made. He did not understand that the rings were separate from the body of the planet. He described them as "handles." Later, the Dutch astronomer Christiaan Huygens (1629-1695) was the first man to describe the rings correctly, saying that a flat ring in an ***ecliptic*** shape circles the planet but does not touch it.

VOCABULARY

Unique: being the only one of its kind; without equal, very different
Ecliptic: the apparent path of a planet as it circles the Sun; appears as a flat band
Density: the mass per unit volume of a substance under specified conditions of pressure and temperature
Styrofoam™: a rigid, brittle, lightweight material made of plastic

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Saturn's rings are made of ice and rock. The rings are not solid, but consist of small chunks of frozen material in a layer



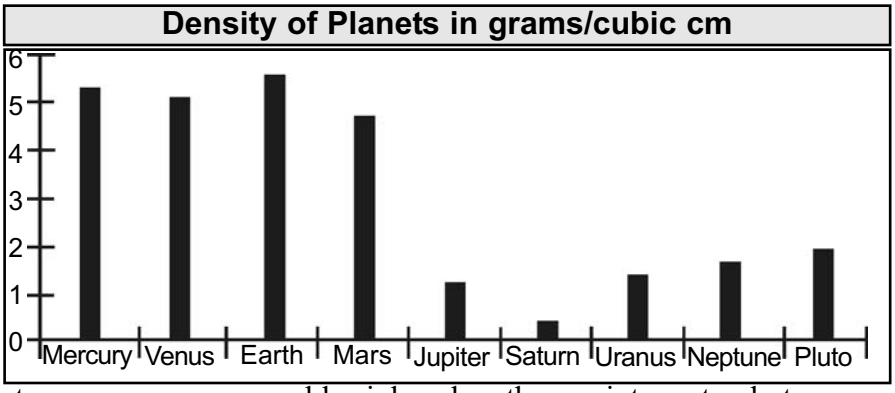
just one or two hundred meters thick. The rings are named in order of their discovery, and from the planet outward are known as the D, C, B, A, F, G, and E rings. They can be described as broad rings, each of which is made up of hundreds of smaller, narrower rings. Each ring is composed of millions of particles ranging in size from specks of dust to chunks of rocks several meters in diameter. As many as 100,000 individual ringlets exists, each of which circles the planet.

Observed through a telescope, the A and B rings are easily visible. The separation between the A and B rings is called Cassini's division, after its discoverer, the French astronomer, Giovanni Cassini. The wide B and C rings appear to consist of hundreds of ringlets that have ripples of varying density. The gravitational interaction between the rings and Saturn's satellites causes these ***density*** waves. Scientists are still studying this interaction to learn more about Saturn's rings.

Early astronomers thought only three rings surrounded Saturn. Since that time, three spacecraft have provided an enormous amount of data about Saturn. The *Pioneer 11* probe flew by in September 1979, followed by *Voyager 1* in November 1980 and *Voyager 2* in August 1981. These spacecraft carried cameras and instruments for analyzing the data collected.

Scientists have learned that although Saturn is the second largest planet in the solar system, it is the least dense. That means the materials of which Saturn is composed are not as tightly packed together as on other planets. Saturn is composed mainly of hydrogen and helium, with a density even less than the density of water. That means Saturn would float!

The planet with the highest density is Earth. You might compare Saturn to a large ***Styrofoam*** ball and Earth to a marble. A marble is very dense, but Styrofoam is not. A marble sinks when thrown into water, but Styrofoam does not.



Saturn has eighteen confirmed moons, and astronomers expect to confirm more. Saturn has more moons than any other planet. The largest moon, Titan, is larger than the planet Mercury and has an atmosphere of nitrogen. These satellites consist mostly of ice and rocky material.

Saturn's atmosphere is composed of 88% hydrogen and 11% helium with traces of methane, ammonia and other gases. The period of rotation of the atmosphere near the planet's equator is about 10 hours and 11 minutes, while the body of Saturn has a rotation period of 10 hours 39 minutes. The difference in these two times indicates that the equatorial winds have velocities close to 1,700 km/h

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(1,060 mph). Such fierce winds stir the atmosphere at such force that they would tear apart any life, as we know it.

Earth/Saturn Comparisons		
	Earth	Saturn
Diameter	12,756 km	120,660 km
Period of rotation	23 hrs. 56 min.	10 hrs. 39 min.
Period of revolution	365.26 days	29.46 years
Average orbital speed	29.79 km/s	9.64 km/s

Saturn is often described as the most beautiful of the planets because of its rings. However, this beautiful planet seems to be in the center of violent storms and vicious hurricanes.

The day was beautiful as you headed to the soccer field with your mom and dad for Maria's party. The fact that the families were also included was nice. That day was to be a unique experience for you, one that you would not forget. A violent storm was just waiting to happen. Like on Saturn, things can appear beautiful on the outside but be filled with turbulence on the inside. The storm you were about to experience was not in the form of weather. It was a storm of violence filled with kidnapping, stolen secrets and intrigue. You and Princess were right at the center of it.

Life Principle

"Outward beauty can be deceiving."

—Anonymous



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Lesson 11
Astronomy

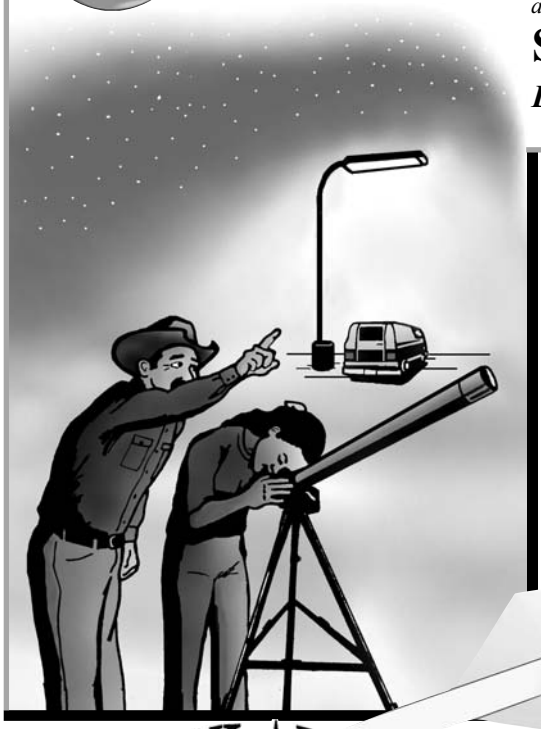
Chapter 4

Constellations, Light Distances and Star Magnitude

Section 3

Lessons 11-15

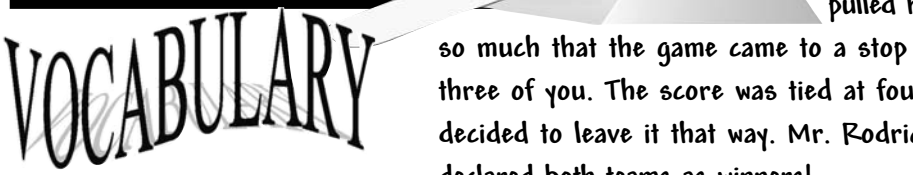
STARS



Everyone was in a festive mood as the Medrano family was introduced. Twins, Isella and Eliana, were your same age. Karina was two years older and Yesima was two years younger. You were right. They were great soccer players! Maria's dad was serving as coach and her uncle as referee. Everything was much more relaxed than a real soccer game, so laughter rang freely as the game progressed. When you and LaToya tripped over each other in the last few minutes of the game, Karina tried to help you both up, but you two pulled her down. You were laughing so much that the game came to a stop and everyone piled on the three of you. The score was tied at four each, and everyone decided to leave it that way. Mr. Rodriquez and Mr. Medrano declared both teams as winners!

Maria's mother called everyone over to picnic tables loaded with food. You decided to check on Princess. You had left her tied to a tree, resting in the shade with a bowl of water and food nearby. Mr. Medrano was petting her as you approached the tree. He explained that he had a dog that looked just like Princess, except that his dog, Confite, was about 4 years older. You told him that Princess' mother, was about 4 years old, too. Princess looked very similar to her mother, who was a good hunting dog.

After dinner, Mr. Medrano set up his telescope. By all standards, it was a small one, but it was large enough for everyone to get a good look at Saturn. You could even see some of the rings. Mr. Medrano pointed out several ***constellations***, and the North Star. Mr. Medrano stepped back so that everyone could have a turn with the telescope.



VOCABULARY

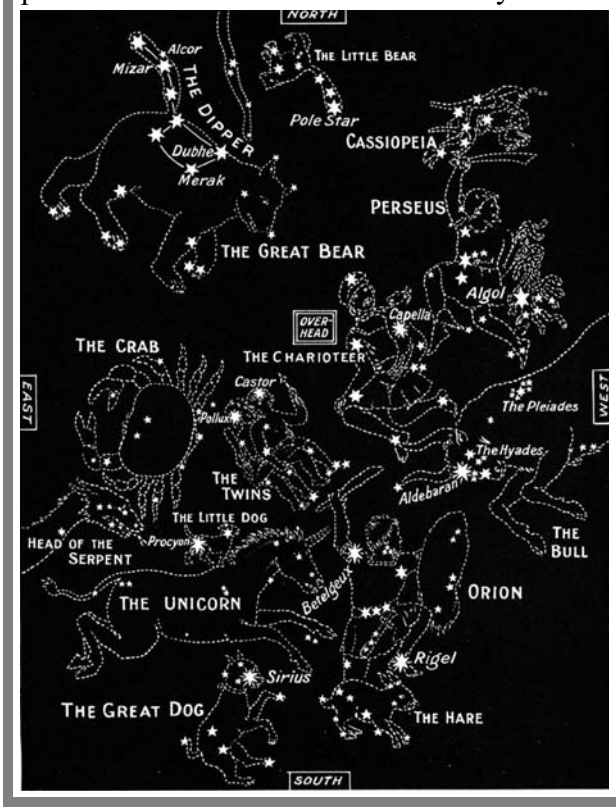
Constellations: stars that appear to form pictures
Boundaries: something that indicates a border or limit
Light-year: distance light travels in a year
Magnitude: the brightness of a star
Spectrum: bands of color formed when light separates
Prism: a transparent solid, usually with triangular ends, used for separating light into a spectrum
Spectroscope: rainbow bands of color formed when light separates

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You decided that was a good time to check on Princess. As you approached, you could hear her making a low, growling sound. As you peered through the darkness towards the soccer field, you saw two people by the goal nearest the parking lot. One of them appeared to be Mr. Medrano. They talked for a few minutes but you couldn't hear what they were saying. The other man returned to the parking lot and drove away in a truck. The distance was too far to distinguish who the other man was.

You untied Princess and took her with you as you walked back to the telescope. Mr. Medrano joined the group a few minutes after you returned and asked if anyone wanted to know how the constellations got their name. As he began his explanation, you noticed a van pull into the parking lot. Princess gave another low growl, but you told her to be quiet. You wanted to know about the stars.

A group of stars that seem to form a picture is called a constellation. Many



constellations were named by ancient people and astronomers who often "saw" designs or groupings in the stars, which they arrived at by connecting the stars with imaginary lines—much like a child's follow-the-dots drawing exercise, but on a much grander scale. Constellations were thus named for various religious figures, animals and objects. New constellations were added to charts at the end of the 16th century when the first explorers of the South Seas mapped the southern sky. Astronomers and navigators from Holland, Germany, and France added to the growing list of constellations. The International Astronomical Union fixed definitive ***boundaries*** for 88 constellations in 1930. Those boundaries remain in effect today.

The stars in a constellation are not all the same distance from the Earth. They are not even all in the same region of space. They only seem to form a flat picture. They just appear on the same plane to us here on Earth. Actually, the distances between the stars within a constellation can be enormous.

Because distances are so great in space, special units of measure are used to express those distances. As you have learned, distances between the planets and the Sun are expressed in astronomical units, AUs. Star distance is measured in a special unit called the ***light-year***. A light-year is the distance that light travels in one year.

DISTANCE LIGHT TRAVELS PER SECOND

kilometers: 300,000
miles: 186,000

To find out how far light travels in one year, multiply the seconds in a year by the speed of light. One year contains 31,536,000 seconds.

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DISTANCE LIGHT TRAVELS PER YEAR

kilometers: 9,460,800,000,000
miles: 5,865,696,000,000

These numbers, rounded, equal almost 10 trillion kilometers or almost 6 trillion miles per light year!

Outside our solar system, Proxima Centauri is the nearest star. It is 4.3 light-years from Earth. Proxima Centauri is approximately 43,000,000,000,000 kilometers from Earth. Scientists work easier with 4.3 light-years than 43 trillion kilometers. That is why star distances are measured in light-years and not in kilometers or miles. This means that the light from Proxima Centauri takes 4.3 years to reach the Earth. And that is one of our closest stars! If Proxima Centauri were to explode tonight, we would not realize it for the next 4.3 years. In the year A.D. 1054, astronomers "saw" a star explode. The star actually exploded in about B.C. 3000. The light reached Earth more than 4,000 years later!

Stars differ in brightness. Scientists call the brightness of a star its ***magnitude***. Three things affect a star's magnitude. First, it depends on the distance the star is from the Earth. A star is like any other light source. The closer a light is, the brighter it seems. The farther away a light is, the dimmer it seems. The closer a star is, the brighter it will seem.

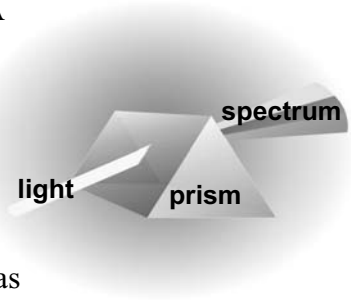


Secondly, magnitude depends on the size of the star. If someone across the room is shining a flashlight at you and, at the same time from the same distance, shining a spotlight at you, the spotlight will appear brighter because it is bigger. A larger star will be brighter than a smaller star at the same distance and at the same temperature.

Third, how bright a star appears depends on the temperature of the star. Suppose two stars are the same in every way except for temperature. The star with the higher temperature will be brighter.

Star color reveals the temperature of the star. Although stars look white to us, they actually range in color from bluish white to yellow, orange, and red. Scientists have determined that very hot stars are bluish white. A relatively cool star looks orange or red.

Starlight, like any other light, separates into bands of color called a ***spectrum*** when it passes through a ***prism***. Scientists can use the light of a star to identify the gases in the star. A ***spectroscope*** separates light into a band of colors. Such a pattern is called a spectrum. Each kind of glowing gas in a star produces a spectrum, which allows scientists to identify the chemical composition of the star. Although most stars are composed of hydrogen and helium, other elements in varying amounts can also be present.



Stars contain large amounts of hydrogen gas. The extremely high temperature and pressure at the core of the star causes hydrogen atoms to fuse, forming helium. This nuclear reaction releases tremendous amounts of nuclear energy.

Because the Earth is spinning on its axis, the Sun and nearly all stars appear to be moving across the sky. One star seen from the northern half of the Earth seems to stay in the same place. That star is *Polaris*, also called the *North Star*. It is found almost directly above the North Pole and is a part of the *Little Dipper*, a constellation known as *Ursa*

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Minor, or *Little Bear*. The North Star marks the end of the handle of the *Little Dipper* and is the brightest star in that constellation.

Those constellations that are close to Polaris can be seen all year from the northern half of the Earth. Constellations that are not near Polaris can be seen only at certain times of the year.

Sirius is the brightest star in the sky, situated in the constellation *Canis Major*. Sirius is also called *Dog Star*. It is one of Earth's closest stars, only 8.7 light-years away. It is more than twice as large as our Sun and can be seen from every part of the Earth.

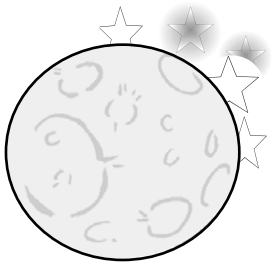
Stars are in our sky even during the day. They do not suddenly "appear" at night. We do not see them during the day because the Sun, our closest star, is so bright that other starlight is too dim, by comparison, to be seen.

Everyone had several turns with the telescope before leaving. Karina walked with you and Princess to your car. Karina told you that Princess reminded her so much of her dog, Confite. You told Karina that Mr. Medrano had said the same thing. You found out that Mr. Medrano was a duck hunter and took Confite on hunting trips. Princess wagged her tail while Karina was talking. You thought one day Princess would be a hunting dog, too.

The party had been enjoyable. You had hoped to spend more time with Karina before she had to return to Mexico; but she ran across the parking lot to join her family as they were loading the telescope into their station wagon. They were parked next to a van and you lost sight of her as you and your family drove away. You looked into the sky and noticed that one star was brighter than the others. It was Sirius, the Dog Star. If you had named that star, you would have called it "Princess, the Dog Star," not Sirius.

Life Principle

"Aim for the Moon. Even if you miss, you'll land among the stars."



—Anonymous

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Lesson 12
Astronomy

Chapter 4

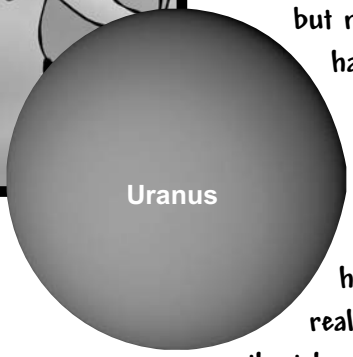
Composition, Characteristics and Comparisons

Section 3

Lessons 11-15

URANUS





The police arrived in a matter of minutes. Maria's family gave as much information as they knew: as Mr. Medrano was about to load his telescope into the back of his station wagon, he was grabbed by two men who had jumped from the nearby van. The men quickly threw Mr. Medrano into the van and sped away. Maria and Karina were able to give the police a description of the van, but not of the men. In the dark, everything had happened too fast!

Your parents and the other soccer parents tried to ***console*** the Medrano and Rodriquez families. No one could imagine why this terrible thing had happened to Mr. Medrano. Karina realized that the men must have also taken the telescope. It was not in the back of the station wagon. Only Mr. Medrano's laptop computer and a briefcase were back there. The rest of their luggage was at Maria's house.

The Medranos were staying with the Rodriquez family, so the police told them to go there and remain by the phone. Perhaps the kidnappers would call, asking for a ransom. The police offered to send a ***surveillance*** team to the house in case a phone call came. Some of the other parents volunteered to keep both families company. Your mom and dad decided to take you home and get a good night's sleep, if at all possible. You and your parents planned to go to Maria's house the next morning to provide breakfast for everyone.

Sleep was difficult. You kept asking why in the world anyone would kidnap Mr. Medrano. He was so nice and had been

VOCABULARY

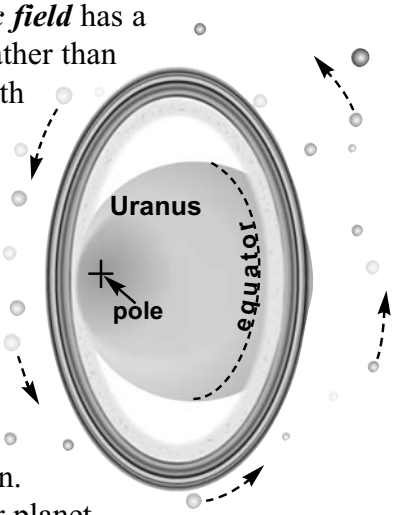
Console: to comfort, to relieve grief or sorrow
Surveillance: close observation of a person or group
Speculated: thought about; theorized; guessed
Tilt: to slope or slant
Magnetic field: a region with a detectable magnetic force

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in the United States only for one day. He certainly did not appear to be rich. You wondered why the men took the telescope. Mr. Medrano's problems started when he was detained at the border. You ***speculated*** that he had information that required a security clearance. You concluded that the telescope and something he knew were all connected to the kidnapping.

Your parents decided to let Princess sleep by your bed that night. With kidnappers in the area, they did not want to take any chances on a surprise visit. You thought about watching Karina walk from your car across the parking lot to her station wagon, which was parked next to the van. The kidnappers must have been in the van as Karina walked past it. That was the same van that ran the red light just a few minutes later. That van looked familiar, but you could not remember where you had seen it. Your mind seemed to be spinning with confusing details involving events of the day. Finally, you fell asleep.

Your mind was not the only thing spinning! All the planets are spinning too. But Uranus is spinning on its side! Uranus, the seventh planet in order of distance from the Sun, has the greatest ***tilt*** of any planet. Uranus is tilted at 98º, which puts it on its side. Earth is tilted 23 1/2º, by comparison. Uranus' ***magnetic field*** has a strange wobble rather than being lined up with its north and south poles.



While tilted on its side, Uranus also rotates backward on its axis. It is the second planet to have this retrograde rotation. Venus is the other planet.

Uranus was not even recognized as a planet when it was discovered. This strange planet was discovered in 1781, by William Herschel who, like other early astronomers, thought the planet was a star. Its first name was Georgium Sidus, which means the Star of George. That name was given in honor of King George III of Great Britain. The name was changed late the 19th century when it was given the name Uranus. According to Roman mythology, Uranus is the father of Saturn.

In 1977, American astronomer James L. Elliot discovered the presence of five rings encircling the equator of Uranus. *Voyager 2*, a U.S. space probe that flew by Uranus in 1986 sent back images showing four more rings. All the gaseous giants, Jupiter, Saturn, Neptune, and Uranus, have rings. As probes send back clearer pictures of the gaseous giants, more rings are being identified, so the numbers are changing as new discoveries are being made.

Ring Systems

Planets	Known rings
Mercury	0
Venus	0
Earth	0
Mars	0
Jupiter	1
Saturn	thousands
Uranus	11
Neptune	4
Pluto	0

In addition to its rings, Uranus has at least 21 satellites, all of which revolve about its equator and move with the planet in an east-west direction. Their orbital paths are "sideways" compared to other planets and moons, because of Uranus' sideways spin. The moons also revolve in a retrograde manner. As with the rings, other satellites are being discovered as technology improves.

Uranus has a diameter of 51,118 km, which makes it about four times the diameter of Earth. Uranus is a gas giant. Its cloudy atmosphere, which is made mostly of hydrogen and helium with traces of methane, appears smooth, with no storms like those visible on

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Jupiter. Through a telescope the planet appears as a small, bluish-green disk with a faint green circumference.

Uranus' period of rotation is 17 hours and 14 minutes. Its period of revolution is 84.04 years. The average temperature on Uranus is ⁻216ºC, which is equivalent to ⁻357ºF. That is much, much colder than any place on Earth!

Earth/Uranus Comparisons

	Earth	Uranus
Diameter	12,756 km	51,118 km
Period of rotation	23 hrs. 56 min.	17 hrs. 14 min.
Period of revolution	365.26 days	84.04 years
Average orbital speed	29.79 km/s	6.81 km/s

Uranus is a strange planet, with its rings and moons, spinning sideways and backwards at the same time! It is probably the most unique planet in our solar system.

When you awoke, you had a strange feeling something was different. Then you remembered about Mr. Medrano. You helped your mom fix sweet rolls, a pot of coffee, and a gallon of orange juice. Your dad loaded everything into the car and you rode with him to Maria's house. Mrs. Medrano had received a call, but it was not for money. The kidnappers had made a strange demand, and you were caught right in the middle of it all. But more about that in another lesson!

LIFE PRINCIPLE

"The more you learn about things that seem strange, the less strange they seem."



—Anonymous

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Lesson 13
Astronomy

Chapter 4

Composition, Characteristics and Comparisons

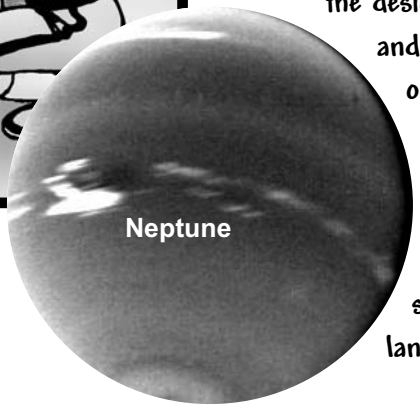
Section 3

Lessons 11-15

NEPTUNE



The kidnappers did not want money in exchange for Mr. Medrano. They wanted information that one of the space probes was to relay back to Earth regarding a spy satellite which was launched about two months earlier from a remote area of Mexico. The satellite was orbiting the Earth, gathering information on nuclear warheads being stockpiled by countries unfriendly to United States interests. Apparently, Mr. Medrano, while working with NASA and United States government officials, was one of the designers of the satellite system and instrumental in its launch into outer space. He was one of the few people able to read the code being sent to Earth from the satellite. One of the space probes recorded the launch of the satellite, and the information landed in the wrong hands.



Karina realized that the telescope her dad brought with him was probably ***calibrated*** in such a way as to receive data from the satellite. That was why both Karina's father and his telescope were taken from the parking lot. Karina suspected that the information the kidnapers wanted was stored in her dad's laptop computer in the back of the station wagon. Apparently, the kidnappers did not realize that the laptop was a necessary component to interpret the system of signals.

VOCABULARY

Calibrated: numerically aligned
Simulate: to imitate or counterfeit
Methane: an odorless, colorless, flammable gas composed of carbon and hydrogen; poisonous to humans

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The police wanted Mrs. Medrano to cooperate with the ransom request. NASA officials and other government agency officials had been notified. The rescue plan was to give the kidnappers a decoy laptop computer which would make them think they could decode the data from the spy satellite. During the exchange, Mr. Medrano would be rescued and the kidnappers arrested. The problem was, how to get enough information out of Mr. Medrano's laptop computer to ***simulate*** the real program. Karina tried several passwords to open Mr. Medrano's program, but all were invalid.

You thought you knew someone who could help. Michael's dad was a computer whiz who could surely help get past the password problem. You called Michael's house only to find out that Mr. Rollins had been called away suddenly the night before to help with an emergency at work. Michael did not know where his dad was or when he would return. Michael said that his dad had never left like that before. After the problem last week with his dad's computer program mysteriously disappearing, Michael and his mother were very concerned.

That scenario amounted to two people who were missing! You wondered whether the disappearance of Mr. Medrano and Mr. Rollins was connected. The two events seemed to have a strange connection.

Neptune was discovered when scientists realized that a large, unknown object was affecting the orbit of the planet, Uranus. The path of the orbit that Uranus should follow was calculated in 1845 by mathematicians. They discovered that Uranus did not always follow the orbit their figures showed it should follow. They reasoned this was due to the gravitational pull of an undiscovered planet and even projected where to look for a new planet. Using information from these mathematicians, German astronomer Johann Gottfried Galle looked for, and was able to discover, a new planet in 1846, which was named Neptune.

Neptune and Uranus are so similar in size and density that they are sometimes called "twins." Their atmospheres and structures are also similar. Neptune's atmosphere is mostly hydrogen and helium. Methane gas in the upper part of the planet's atmosphere gives Neptune a beautiful blue color. Scientists think that its core contains more rock and metal than the cores of other giant gas planets.

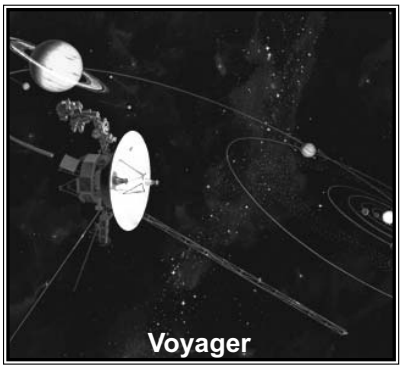
Uranus/Neptune Comparisons

	Uranus	Neptune
Diameter	51,118 km	49,528 km
Density	1.03 g/cm3	1.66 g/cm3
Mass	14.54	17.23

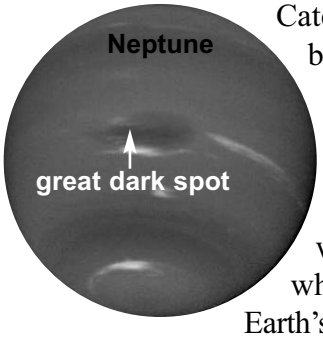
Like the other gaseous giants, Neptune has a system of rings that varies in thickness. However, Neptune's rings contain more dust than the rockier rings of the other planets.

Neptune is usually the eighth planet in distance from the Sun. However, Pluto's orbit is so elliptical that it crosses Neptune's orbit. This makes Pluto sometimes closer to the Sun than Neptune.

Images from the *Voyager 2* probe and the Hubble Space Telescope have revealed active bright and dark spots in Neptune's atmosphere. These spots are thought to be huge storms, which appear to be migrating north and south. *Voyager 2* measured wind speeds on Neptune of 1,500 mph, the highest on any planet. As a comparison, hurricanes on Earth are rated according to their strength, with a


Voyager

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Category 5 hurricane being the strongest possible. A category 5 hurricane contains winds of 155 mph or higher and brings widespread destruction wherever it goes. Earth's strongest winds do not even come close to the average windstorm on Neptune.

Eight known satellites (moons) orbit Neptune. The largest and brightest moon is Triton, which is only slightly smaller than Earth's Moon. Triton has a retrograde orbit. Triton's surface is composed of frozen ***methane*** and nitrogen, making this moon very cold, with a surface temperature of about –235ºC.



Neptune moves very slowly in its orbit around the Sun. In fact, just to complete one trip around the Sun takes Neptune almost 165 years! Since its time of discovery, Neptune has not even made one trip around the Sun.

Astronomers continue to learn more about Neptune from data relayed from space probes and telescopes. Much is still to be discovered about this distant planet.

Earth/Neptune Comparisons

	Earth	Neptune
Diameter	12,756 km	49,528 km
Period of rotation	23 hrs 56 min	16 hrs. 3 min.
Period of revolution	365.26 days	164.79 years
Average orbital speed	29.79 km/s	5.43 km/s

Much data was yet to be discovered, also, about the connection between the mysterious disappearances of Mr. Medrano and Mr. Rollins.

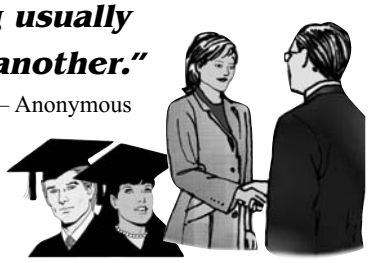
You and Karina decided to jog over to Michael's, taking the laptop computer with you. Michael was great with computers, just like his dad. You thought that perhaps he could help find a valid password to open the program.

Michael took you to his dad's computer by way of the laundry room where Candy and the puppies were. Karina gasped when she saw Candy. She told you that Michael's dog looked just like her dog, Confite. Karina said that they could be twins. She had never seen another dog so close in size, color, markings, and even mannerisms. Michael told Karina that his dog was a great duck hunter. Karina looked at Michael in amazement. So was Confite. Karina explained that her dad took Confite duck hunting every year at a cabin on a lake. Confite was well trained. She even responded to Mr. Medrano's hand signals. Now, Michael was amazed as he explained that his dog responded to hand signals, too. Karina then asked what Michael's dog was named. When he told her his dog's name was Candy, Karina's eyes widened in excitement. That was unbelievable! Both dogs had the same name! Karina explained that Confite is the Spanish word for candy.

Life Principle

"One event, decision or thing usually affects another."

— Anonymous

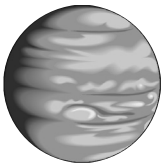


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Lesson 14
Astronomy

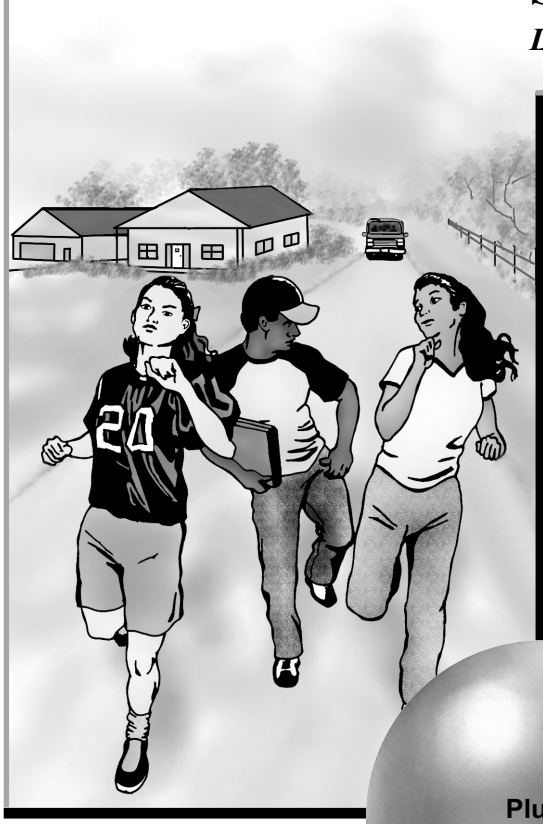
Chapter 4

Composition, Characteristics and Comparisons

Section 3

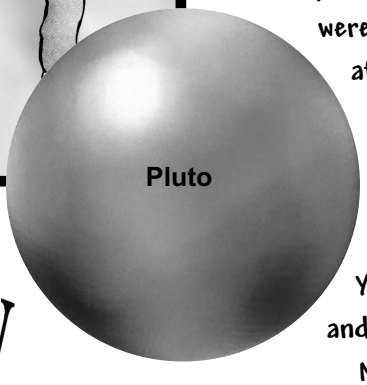
Lessons 11-15

PLUTO



You wondered how everything was fitting together. This puzzle seemed to have so many strange pieces! The disappearance of two men seemed to be connected. You were sure many of the answers could be found in Mr. Medrano's laptop computer, if you could find a valid password to open it. You speculated about the strange coincidence that both men had dogs that looked exactly alike and had the same name; you wondered whether that strange "coincidence" could be a clue to unlocking the mystery.

Michael and Karina compared notes about Candy and Confite and discovered that both dogs were brought home four years ago as puppies after your friends' fathers went on a duck hunting trip to a place called Star Lake. Both dogs had November 15th birthdays. Mr. Medrano and Mr. Rollins must have selected the puppies from the same litter. You suddenly speculated that Mr. Medrano and Mr. Rollins knew one another!



Michael set up the laptop computer in his dad's study and tried to open its program with a password. None of the common passwords worked. While he and Karina were working with the computer, you noticed several star charts on Mr. Rollins' desk. Mr. Rollins must have been interested in astronomy. Michael told you that his dad was working on some type of project with NASA, but it was all very secretive and his dad couldn't talk about it. All Michael knew was that his dad's part of the project was to develop a computer program that could interpret signals from somewhere.

VOCABULARY

Eccentric: departing from a conventional pattern
Inclined: to deviate from the horizontal or vertical; slanted
Absolute zero: a point of temperature (–273ºC) at which all molecules stop vibrating; therefore, a point where there is no heat at all

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That must be it! Mr. Medrano, as an astronomer, was responsible for the design of the satellite. Mr. Rollins, as a computer programmer, was responsible for the interpretation of the information relayed back to Earth from the satellite. They must have met secretly at Star Lake for the past four years to work together.

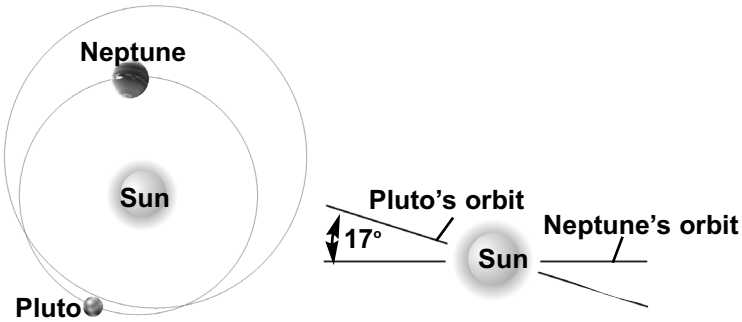
Someone else had made the connection, or both men wouldn't have disappeared at the same time. Maybe Mr. Rollins' computer had some information in it that would help open the program in Mr. Medrano's laptop computer. Michael sat at his dad's computer to work. Michael's password, which opened his own programs, was his dog's name, Candy. Michael typed in "Candy" and had access to his own files. Michael explained that many people use their pets' names as passwords. Mr. Rollins was the one who suggested that Michael use "Candy" for a password. However, using that password did not open his dad's files.

Karina suggested that Michael try her dog's name as the password. After all, the dogs were sisters and had the same name. Michael typed in the word "Confite" and the computer screen filled with charts and graphs. It worked!

Sometimes clues can lead to a new discovery. That's how Neptune was discovered. Remember that mathematicians calculated the orbit that Uranus should follow. When Uranus deviated from that orbit, the mathematicians determined that something with a large gravitational attraction must have been pulling Uranus from its predicted orbit. Astronomers used that information to predict the discovery of another planet beyond Uranus. That mathematical clue led to finding a new planet: Neptuen!

Pluto was discovered in a similar way. Astronomers observed clues that a ninth planet might exist. In 1905, astronomer Percival Lowell predicted the existence of a distant planet beyond Neptune. In 1930, American astronomer Clyde Tombaugh found this small planet, Pluto, near the position Lowell had predicted. However, astronomers were looking for another gaseous giant. What they found was a surprise: a very small planet. Pluto's diameter is only 2,290 km, making it even smaller than Earth's Moon.

Pluto's orbit is so ***eccentric*** that at certain points along its path, Pluto is closer to the Sun than is Neptune. While the orbits of the planets lie close to the plane of the Sun's equator, Pluto has an orbit that is tilted by 17.2º. It has the most ***inclined*** orbit rather than an orbit like planets.

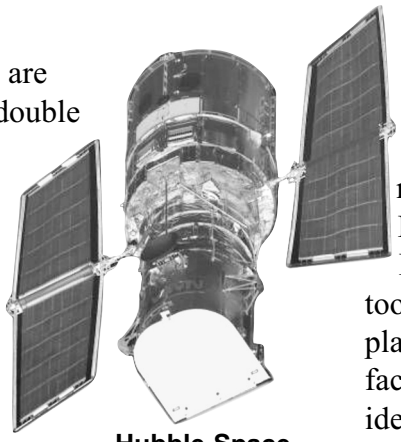


Pluto's average distance from the Sun is 5,899,900,000 km or 39.439 AU. Pluto is so far from the Sun that the temperature is almost ***absolute zero***. Surface temperatures range from ⁻223ºC to ⁻233ºC. That is the equivalent of ⁻369ºF to ⁻387ºF, making Pluto the coldest planet. The coldest temperature on Earth, recorded at Vostok Station, Antarctica, was ⁻89.6ºC, the equivalent of ⁻128.6ºF.

Pluto is visible only through large telescopes. No space probe has ever been to Pluto, but it appears to have a yellowish color. In 1978, astronomers discovered a relatively large satellite orbiting Pluto, and named the moon *Charon*. Pluto's moon is about half the size of Pluto. Pluto and Charon are closer in size than any other planet-moon system in

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our solar system, and are sometimes called a "double planet."



Hubble Space Telescope

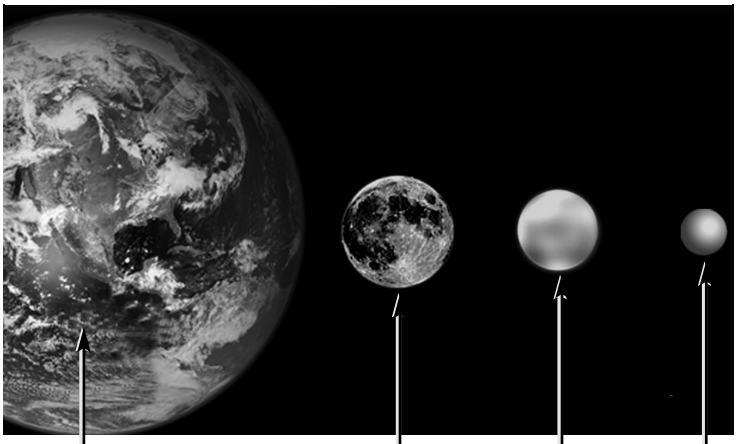
In 1994 the Hubble Space Telescope revealed bright and dark areas of contrast on Pluto's surface. Scientists believe that the bright areas are shifting fields of nitrogen ice. The dark areas are thought to be fields of methane ice. Astronomers have detected a very thin atmosphere of primarily methane gas that escapes into space, due to Pluto's weak gravity.

Pluto is small, like the terrestrial planets, but it is composed of rock and ice. Pluto is not considered either a gaseous giant or a terrestrial planet. The main thing Pluto has in common with planets is that it has a moon. Because it is so unlike planets, astronomers in 2006 reclassified Pluto as a dwarf planet, and not a real planet.

In mid 2002, astronomers Michael Brown and Chadwick Trujillo of the Los Angeles, California area California Institute of Technology (Caltech) discovered a "cold new world" more than half the size of Pluto. The new planet-like object is reportedly a billion kilometers beyond Pluto and orbits the Sun every 288 years. However, the new heavenly body may be too small to be granted recognition as a planet, because size is one of the qualifying factors. So far, the newcomer has an identification number and a tentative name—"Quaoar" (pronounced KWA-WHAR)—suggested by Brown and Trujillo. According to NASA reports, Quaoar is the name of a creation god of the Tongva Indians, the Native American tribe that originally inhabited the Los Angeles area. According to tribal legend, Quaoar "came down from heaven; and, after reducing chaos to order, laid out the world . . . . He then created the lower animals, and then mankind." The Hubble Space Telescope revealed the diameter of Quaoar to be about 800 miles (1,300 kilometers).

As scientists build more powerful telescopes, astronomers will gain fascinating insight into our universe and may have to "correct" charts and books which were considered "true" for many years.

Quaoar's Comparitive Size



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Michael recognized the charts and graphs as part of a computer language designed to interpret data from one system to another. Karina realized that the other part must have been in her dad's laptop computer. She booted it up and tried several passwords including "Candy" and "Confite," but nothing worked. You looked once again at the star charts on Mr. Rollins' desk, searching for a clue—something that might catch Mr. Rollins' interest enough to use as a password. You wondered how Star Lake, where the men got the puppies, got its name. Perhaps it was shaped like a star, or perhaps at night, you could get a good view of the stars. Suddenly you remembered that the brightest star in our skies is called the "Dog Star." You excitedly exclaimed that could be the key!

Before you had a chance to tell Michael the name of the Dog Star, you noticed a van pulling up in front of his house. Then you remembered that little piece of information you had overlooked for the past week.

That van was the same van that blocked the sidewalk last week when you and Princess were jogging from your house to LaToya's house. That also was when Mr. Rollins was mowing his yard, and the same foggy night that you saw the van in front of your house! That van was also the same van you saw later in front of Michael's house when you adjusted the blinds. But more importantly, that was the van that was in the parking lot and later sped by you while you were stopped for the traffic light!

You warned Michael and Karina. Michael grabbed the laptop computer and the three of you slipped out the back door and began to run back to Maria's house where you knew the police were. Unfortunately, the men in the van spotted you and began to chase you. You, Michael and Karina darted behind houses and ran down alleys. You were all in good physical shape, but you wondered whether you would get to safety.

Life Principle

"Do not overlook the little things in life. They may lead to something important!"

—Anonymous



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Lesson 15
Physics

Chapter 4

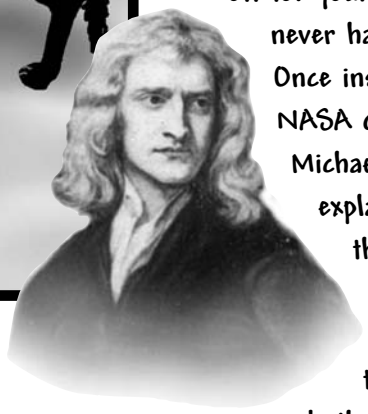
Scientific Laws, Premises and Theories

Section 3

Lessons 11-15

IN THE BEGINNING





You, Karina, and Michael managed to run the two-mile distance from Michael's house to Maria's house, easily leaving behind the men pursuing you. Those evenings of jogging paid off for you! Before soccer season, you could never have run that far or that fast!

Once inside, Michael met with the two NASA officials who were at Maria's house. Michael set up the laptop computer, and explained about the charts and graphs that were on his dad's computer. Michael told the NASA officials that you might know a password that would work. You explained that both men had common interests in their dogs and in the stars. You knew that the Dog Star is the brightest star in our skies. That had to be the key. The name of the Dog Star is Sirius. Slowly, you typed in "Sirius" and pressed the enter key. The password worked!

The NASA officials took over at that point. Between the information Michael gave them from his dad's computer and the information they were able to get from Mr. Medrano's computer, NASA officials were able to make a duplicate program. It was designed to look like the real program but with enough different information so that United States and Mexican security would not be compromised.

The men worked quickly and produced a computer disk that looked just like the original one. The kidnapper called Mrs. Medrano and told her that she had better hand over the disk from the laptop computer if she wanted to see her husband alive. The kidnapper also told Mrs. Medrano that they had another man

VOCABULARY

Ethical: having good, moral standards of conduct and honest motives
Premise: a basic thought system about a matter, from which reasoning proceeds and leads to a conclusion
Prejudice: pre-judging a person or thing before the facts are known
Wavelengths: distances between crests of light waves
Scientific laws: began as theories, tested over time and found to hold true in every circumstance; absolutes (like 2 plus 2 will always equal 4)

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named Mr. Rollins. If Mrs. Medrano supplied the disk, both men would be set free. The kidnappers told Mrs. Medrano to send the disk with the three kids to the parking lot of the soccer field. The kidnappers wanted to question the kids to see how much they knew. No police were to be involved! Only the kids could show up, or the deal was off!

NASA officials worked with the police to determine the best procedure. They decided that the three youth would walk their dogs and take a soccer ball to the parking lot. Once the exchange was made, the police would step in and make an arrest. The police would be posing as soccer coaches working with a team on the field. Maria and her cousins volunteered to be the "team" the police were "coaching."

You had many questions, but you had to wait for answers until the exchange was completed. You wondered how all this got started. You wondered if Mr. Medrano and Mr. Rollins knew in the beginning that the project could be so dangerous. You wondered how the plans were originally designed to carry out this project. You wanted to ask questions about how the project began and what happened along the way. You hoped to get some answers soon.

Most people are like you. They want answers to their questions. People naturally question things about life. In fact, thorough scientists observe the world around them, and inquire why things are the way they are. ***Ethical*** scientists search for truth by asking questions which might produce evidence that could lead to a change of belief.

Getting true answers to questions allows scientists to arrive at conclusions about how or why something works the way it does. Understanding truth requires *empirical* data, which is information that can be seen, felt, smelled, heard, or touched. Scientists use *process* (research) *skills* to identify empirical data. The process skills of the scientific method are: observing, classifying, measuring, experimenting, inferring, predicting, forming models, and interpreting data. However, the key to the scientific method is to use the processing skills correctly.

One scientist's philosophy, ***premise*** or belief system can affect interpretation of the same data studied by another scientist. For example, two persons visiting an art gallery can view a display of paintings, each of which features an exotic bird with one or more yellow tail feathers. One spectator might



VOCABULARY

Entropy: a measure of the disorder or randomness of a system
Radial: moving away in a straight line from a common center
Homogeneous: of the same or similar nature
Intangible: not able to be observed, touched or measured physically
Tangible: able to be observed, touched or measured physically

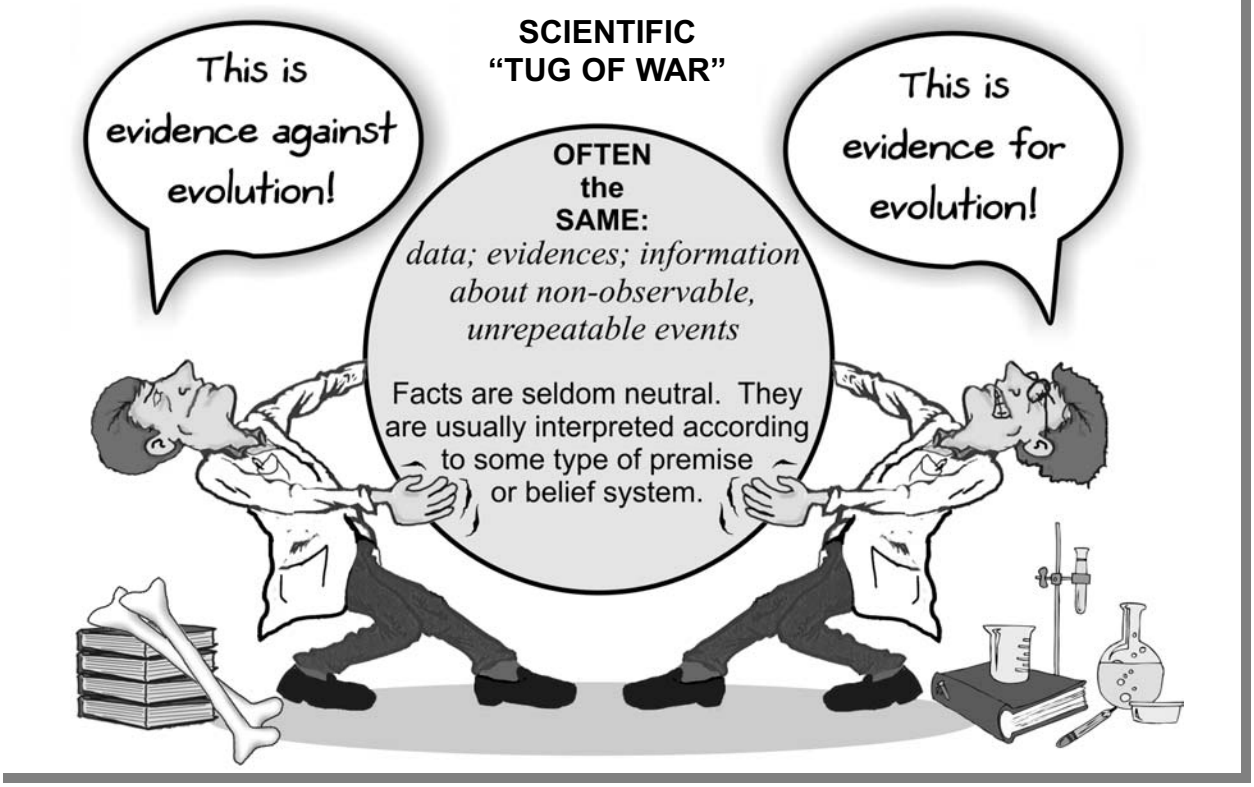
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declare that these paintings give evidence that all of the birds evolved from a common ancestor. The other viewer might conclude that the artwork's similarities were evidence that the artist used yellow tail feathers as a signature characteristic in all of his paintings.

Ethical scientists keep open minds as they use the process skills to discover truth. Unfortunately, less ethical researchers may assume the presence of data that is, in fact, not present. A scientist may incorrectly report that a reaction or consequence occurred because the scientist mixed empirical data with personal ***prejudice***, philosophy or desire for a predetermined result.

Since no human being was an eyewitness to the beginning of the universe, scientists must look at existing data to arrive at conclusions about origin. Scientists disagree over the origin of the universe and life on Earth: either the universe and life therein came into being by chance, or it was created on purpose. Many scientists believe evidence indicates that the universe began by chance or accident, on its own. Some scientists believe the same evidence points to an original cause or creation by a supreme being. These two basic groups are split into sub-groups which propose various theories as to when and how the universe and life came into existence. Other scientists propose a third theory, in which the complexity and design of life and the universe is credited to an unknown intelligence.

People who believe the universe came into being by random chance or accident are usually called *evolutionists*. Evolutionists assume that the universe as we now see it evolved by chance over a long period of time. Supporters of this theory believe that the world and life began in a simple way, then by means of *evolution* of the strongest species became the very complex system in existence today. Evolutionists support their theories with a mixture of scientific data, suppositions, conjectures and theories relating to certain other branches of science, such as astronomy, geology and anthropology.



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Scientists who believe a supreme being *created* the universe are usually called *creationists*. They believe that the universe and life therein was created complex and mature by a creator—God. Proponents of this concept support their theory with scientific data, theories and suppositions, as well as the recorded account of creation in certain ancient Hebrew and Arabic documents. Creationists cite empirical data mentioned in these documents hundreds of years before actual data was discovered by scientists, as evidence of the accuracy of these ancient texts. Creationists point out that these Middle East documents define the Earth as a sphere hanging in space among immense constellations and describe Earth's rotation, gravitation, water cycle and ocean currents which scientists have subsequently verified as scientifically and historically accurate.

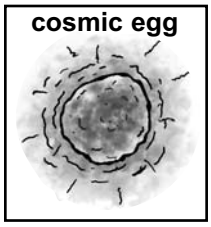
Another group of scientists has proposed the concept of *intelligent design*. They believe that life is far too complex to have happened by chance over eons of time. Proponents of intelligent design are sometimes called *intelligent designists*. They support their theories strictly on the basis of scientific laws and the process (research) skills of the scientific method. These scientists are opposed to the concept of evolution, because they maintain the Theory of Evolution is contrary to several established laws of science. However, designists do not necessarily embrace creationism.

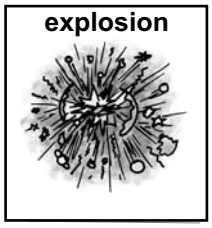
One evolutionary concept, the Big Bang Theory, states that the universe began as a concentrated mass of matter, sometimes called a "cosmic egg." According to this theory, a huge explosion scattered the egg's matter and energy throughout space. At some spontaneous moment, parts of the scattered matter began to collect, or come together, to form stars and galaxies.

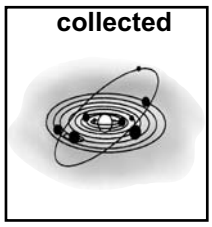
The Big Bang Theory is used to explain the concept of an expanding universe. Some scientists say that everything in the universe is expanding, or moving away ever since the big bang occurred. The evidence, they claim, is found in the study of light waves. Large telescopes are able to study light from very distant galaxies and spread this light into the visible spectrum. Red is at one end of the spectrum with violet at the other end. The longest ***wavelengths*** are red. The shortest wavelengths are violet. Light that is toward the violet or blue end of the spectrum is called a "blue shift" and indicates an approaching object. Light that is toward the red end of the spectrum is called a "red shift" and is moving away from us.

As scientists study the pattern of light, they have observed that light from all distant galaxies is shifted toward the red end of the spectrum. In 1929, American astronomer Edwin Hubble suggested that this "red shift" indicates that these distant galaxies are moving away from us and that the universe is probably expanding. However, moving galaxies can be interpreted in a variety of ways. Just because the "red shift" might indicate expanding movement, no real evidence exists to suggest that movement is equated with the origin of the universe. Perhaps the "red shift" just means movement and nothing else.

Scientists who support the concept that the universe was created refer to ***scientific laws*** as empirical evidence of plan and design. The First Law of Thermodynamics is also called the Law of Conservation of Matter/Energy. This law states that the sum total of matter/energy cannot be created or







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destroyed. Matter and energy can be changed from one form to another but not destroyed. This conservation process can conserve only what was originally evident. Something had to create matter in the first place. If matter/energy cannot be created or destroyed, then the universe could not have created or ordered itself. If the universe began with a cosmic egg, matter still had to have an original source. The idea of a cosmic egg being present to explode in the first place violates the First Law of Thermodynamics.

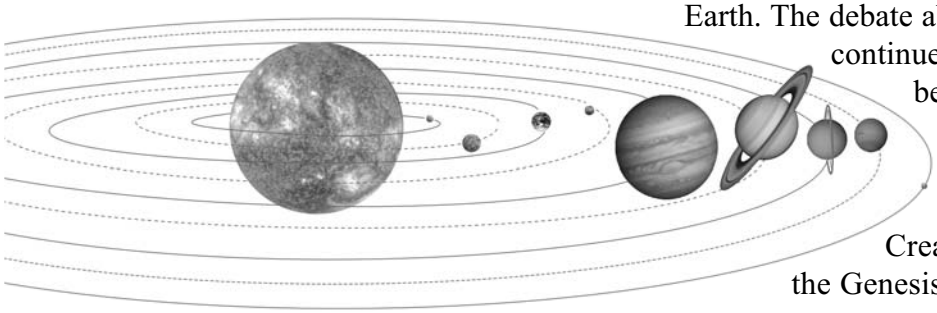
The Law of ***Entropy***, part of the Second Law of Thermodynamics, states that all systems left to themselves tend to become disordered. Increasing entropy means increasing disorder. Creationists use empirical data as evidenced in the world around us to support the belief that things left on their own get worse, wear out, age, and die. They do not get better. For the Earth's complex solar system to come from an explosion of matter would violate the Second Law of Thermodynamics.

Scientists who accept the Theory of Intelligent Design point to the Law of Conservation of Angular Momentum as evidence that a designer would have had to set the planets and moons in their orbits. This law states that pure ***radial*** motion cannot give rise to orbital motion. This means that all the products from the center of an explosion must move outward in a straight line and not stop to begin an orbital pattern. The Big Bang Theory asserts that after a cosmic explosion, parts of matter began to group together to form planets in orbits. However, this supposition violates the Law of Conservation of Angular Momentum.

Creation scientists point to the Law of Gravity as evidence that planets were formed and placed in their orbits with a precise, balanced, gravitational attraction. The Law of Gravity states that gravity depends on two things, mass and distance. Gravity and *mass* are directly proportional to one another. The greater the mass, the *greater* the gravitational pull. However, gravity and *distance* are inversely proportional to one another. In other words, the greater the distance, the *less* the gravitational attraction. The Big Bang Theory contradicts the Law of Gravity when it assumes that as matter was sent into space after exploding from a cosmic egg, and as the distance became greater, the gravitational attraction became greater. No evidence exists to confirm such an assertion. In fact, the Law of Gravity verifies just the opposite.

If the Big Bang Theory were accurate, it would be logical to assume that all planets should be composed of the same substance, since they theoretically came from the same ***homogeneous*** mixture of the cosmic egg. Scientists who accept Intelligent Design point to the great variety in composition of the planets and their atmospheres as evidence of a designer who made each planet individually, Earth being the only solar sphere capable of supporting life.

Many unanswered questions remain about the origin of the universe and life on Earth. The debate about origins will likely continue until the end of time, because each person filters scientific data through a personal belief system. Creationists believe that the Genesis account in the Bible

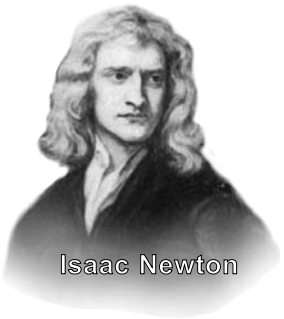


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is verified by empirical data, scientific laws and the absence of transitional fossil forms regarding evolution of life on Earth. Evolutionists believe in the Big Bang Theory as a matter of philosophy and supposition in their search for a purely natural explanation of origins. Intelligent designists believe that the solar system and life on Earth exhibit incredible, complex design that demands the presence of a designer.

Ethical science can only prove a theory true or false based on established scientific laws and the scientific method. In order for a theory to be classified as "fact," everything about the theory must test true. If one part is false, then the entire theory is false. For example, you have probably answered "True or False" questions on a school quiz. If the entire statement is true, the answer you should give is "true." However, if any part of the statement is false, the entire statement is false, and your answer should be "false." A theory cannot be considered as scientific fact until all components can be validated as true.

Many ***intangible*** things in life, such as love, joy, peace of mind, spirituality, artistic ability, or speculations about the unobservable past cannot be measured by ***tangible***, scientific methods. An ethical scientist looks at observable data, compares it to accepted laws of science, and uses the process skills of the scientific method to arrive at a conclusion about the item under investigation. True science does not base conclusions on conjecture, suppositions, prejudices or preconceived ideas.


Isaac Newton

Sir Isaac Newton (1642-1727), British inventor of the reflective telescope, is considered to be the greatest scientist and astronomer of all time. At one point, he constructed a miniature model of the solar system. A story is told of a visiting fellow-scientist who exclaimed, "My, what an exquisite model that is! Who made it?" Knowing that the visitor did not believe in a Supreme Designer, Newton replied, "No one!" The scientist scowled and retorted, "Do you think I am a fool? Of course someone made it, and a genius at that!" Newton smiled at his friend and said: "This thing is but a puny imitation of a much grander system whose laws you and I know. I am not able to convince you that this mere toy is without a designer and maker; yet you profess to believe the great original from which the design is taken has come into being without either designer or maker. By what sort of reasoning do you reach such a conclusion?"

You had unanswered questions, but you had a job to do. Michael retrieved Candy and you got Princess. Karina brought a soccer ball and the computer disk. As you tried to act natural in the parking lot, Karina began to kick the soccer ball to you. On the soccer field, the "coaches" were instructing their "players." The van pulled into the parking lot and three men got out. You could see Mr. Medrano and Mr. Rollins in the van. They looked worried.

The kidnappers approached you and asked what you knew about the computer disk. You told them that you knew it belonged to Mrs. Medrano who asked you to take the dogs for a walk and to give the disk to some men who would be in a van. She said the disk had something to do with a project for her husband's work. Karina started to hand over the disk as one of the men looked towards the soccer fields. He recognized one of the coaches as a policeman and began to yell a warning. As he yelled, he reached to grab you as a hostage. Karina gave a hand signal and Candy attacked the man, freeing you. You gave

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a swift kick to the soccer ball. It knocked the second man in the head and he fell backwards. Princess followed Candy's lead and attacked the third man. Michael jerked open the van door and untied his dad and Mr. Medrano. The police handcuffed the three men and took them away. NASA officials arrived to recover the phony disk and to thank you, Michael, and Karina for your bravery. Public recognition for your actions was not permitted because of the top-secret status of the operation, but NASA officials promised to treat your soccer team to a pizza party and to donate a telescope to each of your schools. You were glad that Michael's dad and Karina's dad returned unharmed.



Questions still rumbled around in your mind about the whole ordeal. You asked Karina how she knew Candy would respond to a hand signal. She told you that she remembered Michael saying that his dog was trained with hand signals. Karina said that her dog was also trained with hand signals. She figured that both dogs received the same training while they were at Star Lake. You congratulated Karina on her quick thinking. She congratulated you on your quick kick!

Your next questions were directed to Mr. Medrano and Mr. Rollins. You wanted to know how the mystery got started. In the beginning, both men were contacted by NASA to work on a top-secret matter of national security. That was five years ago. Both men were experts in their fields of astronomy and computer science. Together, they designed a satellite system to keep track of nuclear warheads being stockpiled by other countries. When Mr. Rollins' computer was suddenly infected with a computer virus and his programs stolen, NASA officials knew that someone was trying to sabotage United States security. Mr. Medrano and Mr. Rollins were asked to design a backup security system for the satellite program as quickly as possible. Mr. Medrano was brought to the United States to confer with Mr. Rollins. The appointment to speak at a university was arranged as a distraction from the real purpose of the visit.

The men had previously worked on the program during duck hunting season at Star Lake. However, the problem was so urgent that they could not wait until the next duck season. They had to find a way to meet without calling attention to their plan. The idea about the astronomy lecture at the university was the result.

Mr. Rollins had suspected that the men in the van were observing him. That was why he was mowing his grass the evening you jogged from your house to LaToya's house. He was mowing his yard while trying to get a good look at the men. They were acting like they were making a delivery several doors from the Rollins' house. What they really were doing was setting up a surveillance camera on the Rollins' house. The men caught you on tape several times, but it was because you were visiting Candy and her puppies, not because you knew anything about the top-secret project. The men followed you home several times, trying to see if you were part of the project.

Well, that answered almost all your questions. You knew that life was very complex

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and not often as simple as circumstances appear. You realized that one thing can lead to another, and that while you should not jump to conclusions, you should be observant of your surroundings. And you understood how important little things could be if you were trying to arrive at truth. You had just one additional question: you wanted to know if Maria's cousins could finish their visit. That could be the beginning of a great soccer match!

LIFE PRINCIPLE

"Truth will always be truth, regardless of lack of understanding, disbelief or ignorance."

—W. Clemet Stone



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