

UNIT 3- CHAPTER 10: VENUS

Morning Star/Evening Star

- only visible for 3 hours after sunset and/or 3 hours before sunrise

Atmosphere

- dry, extremely hot

“Venus Express”

- launched in 2005 by the European Space Agency
 - focused on collecting data from the atmosphere

Basic Planetary Facts	Atmospheric/Greenhouse/Hydrosphere	Geology
- close to Earth's size, mass and gravity	- covered with a thick blanket of clouds consisting of sulfuric acid resulting in a high pressure at surface	- few impact craters; surface has been resurfaced by Basalt lava flow
- slow rotation is retrograde (spins clockwise)	- 96% carbon dioxide, 3% nitrogen; produced by extreme volcanism	- evidence of tectonic activity under crust but no plates
- no satellites	- no water; when greenhouse was building up to full strength the surface was cooler resulting in water	- weathering/erosion evident on surface; produced by wind
- small magnetic field produced by the atmospheric interaction with solar wind	- “Venus Express” shows the planet has intense cyclonic storms	-interior: mix of rock and metal; extremely hot
		- surface is dominated by volcanic features: coronae, pancake volcanoes, immense calderas

coronae- huge domes surrounded by concentric features (formed by mantle plumes that bring magma right up under crust)

pancake volcanoes- flattened domes formed by magma, flattened by high pressure in atmosphere

immense calderas- deep volcanic crater result of a coronae blowing up

Four Stages of History:

1. Differentiation - separation of materials according to density
2. Cratering - a period of violent impacts
3. Flooding- lava flow
4. Slow Surface Evolution

UNIT 3- CHAPTER 11: MARS

Planetary Facts	Weather/Atmosphere	Geology
- half the size of Earth	- 95% carbon dioxide, 1% argon, 3% nitrogen	- no plate tectonic; crust never been broken
- much lower density than of Earth	- cold, dry, scattered (rare) clouds of ice crystals	- home to the largest volcanoes in the solar system; Olympus Mons (shield volcano)
- nearly the same obliquity, tilt and rotational period as Earth	- strong winds causing erosion	- “Valles Marineris”: network of canyons stretching 4000 km long and 600 km wide
- two satellites: Phobos and Deimos	Water & Ice - evidence of polar ice caps causing craters; as well located at North & South poles - water chemically bound in minerals/rock - permafrost exists just below the surface	- evaporite minerals present; if there was water present it must have evaporated resulting in leftover minerals
		- “red bed”: red colour deposits caused by the mineral hematite (red iron oxide)
		- interior: core is not solid, thick liquid; crust has become thicker over time

Missions

On Surface: Mars Curiosity, Mars Opportunity/Spirit, Phoenix Lander

In Orbit: Mars Odyssey, Mars Express, Mars Reconnaissance Orbiter

- Curiosity: Launch November 26, 2011 and landed on Aeolis Palus crater on August 6, 2012, at a site now called Bradbury Landing

shield volcano - inverted warrior shield shape (sinking into crust)

blueberries- small spherules scattered over some areas of soil

Four Stages of History:

1. Differentiation - differentiated into a core, mantle and crust
2. Cratering - cratered by debris of early solar system
3. Flooding- lava flow smoothed regions on surface, may have included water
4. Slow Surface Evolution- crust is thicker, lost internal heat, lacks molten core

UNIT 4- INTRODUCTION

Discover of Ceres

- “Ceres” is the first asteroid discovered from the asteroid belt
- it was discovered in 1801 by Giuseppe Piazzi

meteoroid- natural rocky object in space measuring from a few millimeters to 100 meters in diameter

asteroid- natural rocky object in space measuring from 100 meters to several kilometers in diameter

meteorite-a fragment (of any size) from either a meteoroid or an asteroid that lands on Earth's surface

meteor- visual streak of light of a small meteoroid as it passes through Earth's atmosphere

fireball- the light associated with a large meteoroid or asteroid as it interacts with the atmosphere

fireball- the light and sound associated with a large meteorite or asteroid as it interacts with the atmosphere

meteor- visual streak of light of a small meteoroid as it passes through Earth's atmosphere

Titus-Bode Law/Rule

- scientist Johann Daniel Titius discovered a mathematical equation in 1766 to relate the relationship between planets and their orbits
- given the number sequence (0, 3, 6, 12, 24) notice how the following number is doubled
- with the sequence add 4 to each number resulting in (4, 7, 10, 16, 28)
- divide each number by 10 resulting in the approximate distance each planet is from the next

UNIT 4- CHAPTER 12: ASTEROIDS

Main Asteroid Belt

- Consists of thousands of asteroids
- Located between the gap of Mars and Jupiter

Jupiter Effect

- because of Jupiter's large mass, its gravity dramatically affects the motions of small bodies anywhere close to it
- the gravitational pull from Jupiter and the Sun offset each other creating the belt

Why the Gaps (Between Asteroids)

- Kirkwood Gaps: gaps corresponding to simple fractions of the orbital period of Jupiter causing an inconsistency in a constant pattern in the belt

Classification of Asteroids

- Close to the sun- brighter and have a higher metal content
- Further from the sun- darker in colour and rich in carbon

1. 93% of meteorites are composed of minerals called silicates (oxygen plus silicone)
2. Albedo measurements (proportion of light reflected from an object; range= 0, black... 1, light reflect and consist of lots of metals)
3. Break down the reflection of light created by the asteroid

C-Type Asteroids	(Carbonaceous) - high carbon content - 75% of known asteroids, similar to the sun - located closest to P and D type
S- Type Asteroids	(Siliceous) - high silicon content - 17% of known asteroids
M- Type Asteroids	(Metallic) - high metal content - remaining known asteroids

Families

- Within the Main Asteroid Belt asteroids cluster together because they have the same orbital characteristics

Non-Belt Asteroids

- Asteroids that do not orbit in the Main Asteroid Belt
- Asteroids not orbiting in the MAB orbit close to Earth; called Near Earth Asteroids (NEA) or Near Earth Objects (NEO)

Atens- most of these asteroids have orbits less than 1AU (orbit within Earth's orbit)

Apollos- orbit brings them through Earth's orbit (they cross over Earth's path and hit Earth every 250,000 years)

Amors- orbit around Mars' orbit but come extremely close to Earth

trojan asteroids- icy asteroids not part of the Main Asteroid Belt

potentially hazardous asteroids (PHA's)- minimum 150 meters in diameter and orbits closer than 0.5 AU to Earth

Impact Risk & Torino Scale

- Torino Scale ranges from 1-10 (1 being not dangerous and 10 being life threatening)
- measures how much of an impact risk an event is

Asteroid Exploration

- goal to take pictures of asteroids as well as investigate the different characteristics
- first picture was taken in 1991 of "951 Gaspra"
- The first asteroid probe= NEAR (Near Earth Asteroid Rendezvous) Shoemaker

Eros

- first and largest of the NEO's to be discovered

Itokawa

- space craft Hayabusa from Japan was meant to land on the NEO
- landed on the asteroid, had issues and without scientists knowing had sealed samples of the asteroid; lost signal

UNIT 4- CHAPTER 13: METEORITES

find- stumble across a meteorite with no info on how it got there

fall- entry through the atmosphere had been eye witnessed and someone recovered a piece of the object

Classification

- According to what they are composed of; irons, stoney irons, stones

Irons (5%)	- almost entirely made of iron plus nickel metal alloys
Stoney Irons (1%)	- 50/50 (iron and non-metallic silicate/oxide)
Stones	- almost entirely latter matter
---> Chondrites (contain chondrules) (86%)	- cosmic sediment; never altered since being compressed
---> Achondrites (no condrules) (8%)	- igneous rocks that have been at least partially melted and re-crystalloid

condrules- round grains found in chondrites; form as molten or partially molten droplets in space before being compressed

meteors- (also known as interplanetary dust particles) that are the smallest meteoroids in our solar system (one thousandth of a millimeter)

meteor shower- the process of multiple meteors of entering the atmosphere causing light

Comets

- rocky object made of ice and dust, when near the sun or light is reflected a “tail” of gas and dust particles appear
- Temple Tuttle Comet: left so much dust behind it was referred to as “Great Leonids Shower”

fireball- meteors enter Earth’s atmosphere with a light and sound show

Kinetic Energy

- $KE = 1/2mv^2$

m= mass v=velocity KE= kinetic energy

Tools for Inspection

petrographic microscope- allows people to see the exact composition of the rock

electron microprobe- uses a tiny beam of electrons to impact micron-sized volumes of the sample and know what elements are present in what volume/proportions

mass spectrometer- measures amounts of radioactive isotopes to determine the age (working clock)

UNIT 5- INTRODUCTION

gas giants (also known as Jovian Planets or Ice Giants)- large, massive, low-density planet comprised primarily of hydrogen, helium, methane and ammonia in either gaseous or liquid state

- formed in the last 10 million years

collision of comet Shoemaker-Levy 9 & Jupiter- strong gravitational pull increases chance of collision; comet was captured into orbit, broke into 21 separate pieces that looped out; within a time span of 6 days all 21 pieces slammed and collided with Jupiter

Satellites

regular- define the outer orbital reaches of a planet's domain in space

irregular- of unknown origin; start orbiting with beginning of planet

trojan- orbit the sun but are gradually bound to the planet

	JUPITER	SATURN	URANUS	NEPTUNE
PLANETARY PROPERTIES	Distance: 5.3 AU Density: Low Rotation: Fast (9hr) Inclination: Upright	Distance: 9.5 AU Density: Very Low Rotation: Fast Inclination: Tilted (able to see rings from Earth)	Distance: 19.2 AU Density: Low Rotation: Inclination: Rotates on its side	Distance: 30.1 AU Density: Low Rotation: Inclination:
MISSIONS	Pioneer 10 & 11 Voyager 1 & 2 Juno New Horizons Galileo	Pioneer 11 Voyager 1 & 2 Cassini-Huygens (New Horizons)	Voyager 2 (New Horizons)	
ATMOSPHERE	Organized into belts and zones	Gaseous atmosphere into liquid planet (no surface) Organized into belts and zones ; hard to distinct clouds Strong winds	Consisting of methane and both have thick layers of slush "ice" beneath those atmospheres Neptune Core Temp: 7000K Uranus Core Temp: 2000K Cyclonic storms/Strong winds	
SATELLITES/RINGS	63 Satellites (including 4 Galilean Moons)	7 Rings 62 Satellites (Galileo discovered planet; Rings discovered by Huygens)	13 Rings (Dust/Carbon) 27 Satellites (5 large)	13 Satellites
GEOLOGY	No hard surface; rocky core	Very hot core Strong magnetic field	Uncertain due to the fact there has been no missions	

UNIT 5- CHAPTER 14: JUPITER

New Horizons- space craft heading for Pluto that passed by and took pictures

Galileo- only space craft to orbit; sent to research atmosphere, satellites, surrounding magnetosphere

- Destroyed by being pulled into the atmosphere
- Reason we believe that Europa could have a salt water ocean/microbial life

Atmosphere

dark belt- (reddish/brown) higher temperature, positioned lower, descending gas, high pressure

bright zone- (white/yellow) lower temperature, positioned higher, rising gas, low pressure

- cause fast rotation

dark spots- openings where we see deeper darker clouds

white spots- higher cloud circulations

- fast turbulent winds caused the "Great Red Spot"

- weather patterns dominated by interior; internal heat rising from interior

Satellites

Galilean Moons- 4 objects (largest satellites) that were discovered by Galileo Galilei

- tidally locked to Jupiter (keeping the same face to Jupiter at all times)

- Names: Callisto, Ganymede, Europa, Io

UNIT 5- CHAPTER 15: SATURN

Cassini-Huygens- first space craft to orbit Saturn; reason where we have most of our information
- explored rings and satellites of orbit

New Horizons- cut through the orbit of Saturn to reach Pluto

Rings

Discovered by: Christiaan Huygens

Why they “hug” equatorial plane: Gravitation pull from Saturn lines them up

What they are made: Composed of billions of particles of water ice (95%)

Origins:

1. Assumed the rings were ancient and made the same time Saturn was made-or at least shortly after. Voyager did research and realized the rings were young (100,000 years old)
2. Rings were once a (water ice - rocky core) satellite of Saturn whose orbit decayed until it came close enough to be ripped apart by the tidal force

Role of Shepherd Satellites:

- satellites throughout the rings; they disintegrate replenishing the ring material and sometimes the ring material accretes into small satellites

Satellites

- *One really big satellite (Titan), about seven which are medium size, and then a whole bunch of tiny ones*
- *All icy satellites are unique, no two are the same*

Titan

- Only satellite to have a dense atmosphere; nitrogen
- Surface: one large continent and surrounding oceans; impact craters, volcanoes,
- Cryovolcanoes: signify the product is cool to cold water and ices of various sorts

Enceladus

- Orbits extremely close to Saturn at a fast speed
- Some craters, some resurfacing
- Has plumes of icy salt water and snow spewed from fountains along the troughs
- No internal heat, “frictional kneading” of the satellite by tidal attraction

UNIT 5- CHAPTER 16: URANUS & NEPTUNE

- ice giants

Satellites

Triton

- orbits in a circular path but it travels backward- opposite way that Neptune rotates
 - the only large satellite in the solar system with a retrograde (backward orbit)
- Future predictions: Though it is stable right now, the satellite will break up or crash into Neptune

Nereid

- travels in the right direction but its orbit is highly elliptical and very large

UNIT 6- CHAPTER 17: PLUTOIDS AND TNO'S

trans neptunian object (TNO)- icy bodies beyond the orbit of Neptune including anything in the Kuiper Belt and Oort Cloud

dwarf planet- share same characteristics of a planet but not as large in size

plutoid- pluto-like trans neptunian dwarf planet

- orbit the Sun at an average distance greater than Neptune
- large enough that its gravity brings it to hydrostatic equilibrium making it near-spherical
- not cleared the neighborhood around its path from other orbiting debris

Discovery of Pluto

- Clyde Tombaugh used 14x17 inch glass plates that were exposed three days apart
- They were mounted in a “blink comparator”- machine that allows someone to look through a microscope at a small spot on one plate then flip a lever to see the same spot on the other plate
- Tombaugh was searching for a change in movement

- Discover of pluto shocked many people due to the prediction the planet would be 7 times the size of Earth; Pluto was smaller than the moon

Planetary Facts

- Pluto's orbit is unlike anything other; rather than a circular orbit, it orbits an elliptical pattern
- Density twice that of water; assuming interior is solid
- Tilt gives opportunity for different seasons but there is no heat
- Composition: frozen nitrogen, water ice, mix of silicate rock and water ice

Charon

- satellite of Pluto
 - tidally locked to each other
- “balance point” or “mid point” of gravity is not in pluto but somewhere in between the space of Pluto and Charon
 - for Charon to be a satellite the “balance point” would have to be in Pluto; results in binary (dwarf) planet system

Eris

- Largest TNO discovered so far
- Orbits the sun in an elliptical path that is past pluto

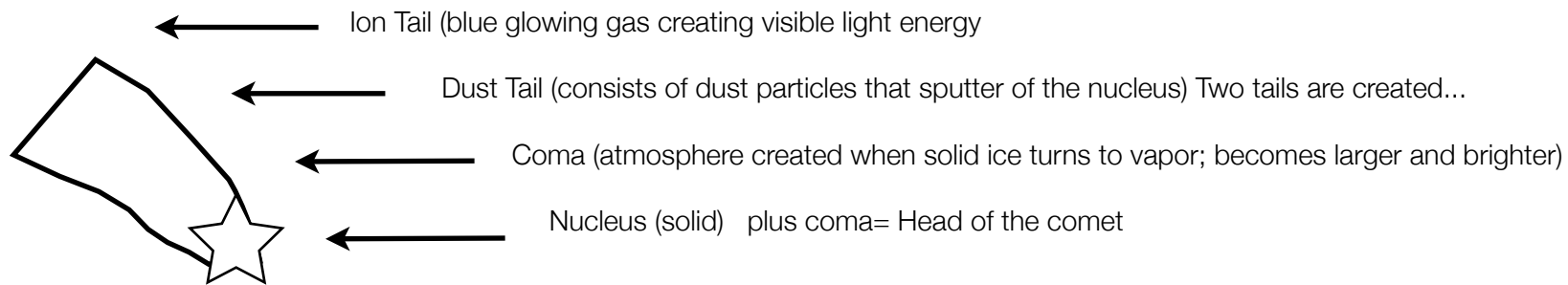
UNIT 6- CHAPTER 18: COMETS

comet (aka. dirty snowball)- small mainly icy object that streak through the solar system along long sun-orbiting elliptical tracks; as they warm within the inner solar system the frozen gases begin to vaporize leaving visible track across space

Why Study Comets?

- Oldest, most primitive bodies in the solar system, possibly comprised of some of the basic building blocks of life
- Possibly brought amino acids to Earth promoting life

Anatomy



Orbits

short period- orbit period of 200 years or less

long period- takes millions of years to complete a single orbit around the sun

Life and Death

Lives of active/short period comets are limited due to:

1. The nuclei are losing mass at rates that cannot be sustained for very long
 - when close to the sun the solid nucleus turns directly to gas
2. The active/short period comets are under the gravitational control of other planets
 - the gravity of other planets can eject comets from the solar system, inject them towards the sun, or get absorbed by an impact with one of the planets

lifetime of comet- the dynamical lifetime of a typical short period comet is about 0.5 million years

- Seems reasonable that comets were formed with the beginning of the solar system and have been stored in a cold place where the nucleus ices would be stable:
 - Kuiper Belt
 - Oort Cloud

Kuiper Belt

- At least 100,000 icy objects orbiting past Neptune
- Observations show comets are confined within a thick band meaning they occupy a belt around the Sun

Oort Cloud

- Spherical cloud of icy bodies believed to extend from 10,000 to 100,000 AU from the Sun
- Far from the Sun they are very cold, lack comas, and tails are invisible

Exploration Missions

- Comet Halley
- Comet Borrelly
- Comet Wild 2
- Comet Temple 1

UNIT 7- CHAPTER 19: LIFE IN THE UNIVERSE

life/life forms- can reproduce and carry out process by which they can grow and live

ex. Bacteria is life form; Virus is not (cannot live without host cells)

Life

Cellular organisms:

- are carbon and water based
- contain genetic information sufficient to reproduce
- possess the abilities to undergo metabolism
- respond to stimuli
- adapt (through natural selection) to environment

All organisms that have essential characteristics of life are composed of discrete units called **cells**.

cells- smallest unit that have the properties of life and all organisms are composed of one or more

- Within cells: the ability of life to reproduce and self-regulate is based on the interaction between compounds known as nucleic acids and proteins

- Nucleic Acids: sugar, phosphate group and nitrogen compound

- They bond together to create complex patterns

- EX. DNA (Deoxyribonucleic Acid)- genetic info

- EX. RNA (Ribonucleic Acid)- carries out the coded instructions given by DNA

Evolution

- The ability organisms have to adapt to new environments/surroundings is caused by ability DNA has to be changeable and adaptable
 - If not changeable, species would die

Natural Selection

- Survival of the fittest
- Each time offspring are born they receive data that's stored in DNA, not the same DNA for each offspring
 - Merciless to the individual but gives the species the best chance for survival

Miller-Urey Experiment

- Used lightning as a base to see how it affected the Earth's atmosphere
 - Discharged an electric spark into a mixture thought to resemble the atmosphere
 - In a water receptacle (modeling the ocean) amino acids appear
- Amino Acids are considered the building blocks of life (every cell)

Murchison Meteorite

- Meteorite landed in Australia
- Found to contain a large variety of organic compounds including amino acids

Origin of Earth Life

- Earth's first oceans were filled with rich mixture of organic compounds called "primordial soup"

prokaryotes- single cell organisms containing DNA but no nucleus; asexual

- Produce oxygen but when exposed to oxygen they die
- In anaerobic (lacking free oxygen) environments blue-green bacteria (colonies of these are called stromatolites) exist and have been unchanged from 3.5 billion years ago
- They were able to survive then because the ocean was filled with dissolved iron absorbing the oxygen

eukaryotes- larger cells organized with DNA and nucleus, use oxygen for energy; sexual

- Began to exist 1.5 billion years ago
- Caused the growth of an oxygenated atmosphere

OZone

- Without oxygen there would be no OZone
 - Used to shield the Earth from harmful radiation
 - Need atleast 2% oxygen in atmosphere to form OZone

Life Elsewhere

Less Likely

Moon- airless, no liquid water

Mercury- airless, cannot have water on surface

Venus- has traces of water vapor in atmosphere but surface is too hot

More Likely

Europa (Satellite of Jupiter)- has liquid water ocean below its icy crust, minerals in water would present possibilities

Ganymede (Satellite of Jupiter)- has liquid ocean

Titan (Satellite of Saturn)- atmosphere of nitrogen, argon, methane; may have oceans of liquid methane and ethane on surface (resembles Earth from 4.6 billion years ago)

Mars- found ancient life in Murichson meteorite; methane gas on Mars could be a step closer to life

Outside the Solar System

life zone- need for liquid water

- Orbiting a star no colder than the Sun
- Have planet remain in the life zone for 4-5 billion years, must form on surfaces and outer edge

Gliese 581

- Small red dwarf only 20.5 light years away from Earth
- 6 planets orbiting around
- Gliese c,d,g have chance of water because they are located in the habitable zone (sometimes called the “goldilocks zone”)

SETI= Search for extraterrestrial Intelligence

Arecibo Message (1974)

- Radio telescope from Arecibo, Costa Rica sent a coded message aimed toward globular star cluster (M13)

Water Hole

- Limits the search for sending radio signals
- Send wavelengths in the water hole because it will reach planets in the habitable zone
- In between the line of neural hydrogen and hydroxide is the waterhole because the combination yields water

Mass Extinction

- Wipe out humanity, Earth periodically gets hit by asteroids/comets

Characteristics:

1. Very short period of catastrophism
2. Global Extent
3. Turmoil in both marine and terrestrial environment