Space Links: **NASA** http://www.nasa.gov/home/index.html

1.0 Human understanding of both Earth and space has changed over time.

http://www.astro.washington.edu/larson/Astro101/lectures/OriginTime/origin_universe.html

1.1 Early Views About the Cosmos

Objects in the sky have fascinated humans throughout time. The explanations of how these celestial objects came to be are even more fascinating.http://www.utsc.utoronto.ca/~shaver/ancient.htm

Ancient Views of the Cosmos

Myths, folklore and legends were used to explain what ancient people observed in the night sky.

- **First Nations people of the Pacific Northwest** - believed the night sky was a pattern on a great blanket overhead, which was held up by a spinning 'world pole' resting on the chest of a woman named *Stone Ribs*.
- **Inuit in the high Arctic** - used a mitt to determine when seal pups would be born, by holding the mitt at arm's length at the horizon.

Solstice - represents the shortest and longest periods of daylight
Winter solstice - shortest period of daylight (Northern hemisphere - Dec. 21)
Summer solstice - longest period of daylight (Northern hemisphere - June 21)

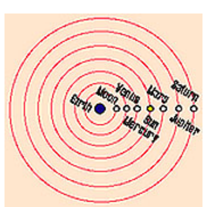
- The **Ancient Celts** set up megaliths, in concentric circles, at **Stonehenge** to mark the winter and summer solstices.
- **Ancient African cultures** set large rock pillars into patterns to predict the timing of the solstices as well.

Equinox - represents periods of equal day and night
Autumnal equinox - occurs in the fall (Northern hemisphere - Sept. 22)
Vernal equinox - occurs in the spring (Northern hemisphere - Mar. 21)

- **The Mayans of Central America** built an enormous cylinder shaped tower, at **Chichen Itza**, to celebrate the two equinoxes.
- **The Ancient Egyptians** built many pyramids and other monuments to align with the seasonal position of certain stars.
- **Aboriginal Peoples of Southwestern Alberta** used key rocks, which aligned with certain stars, in their medicine circles.Ancient cultures tried to explain the motions of the stars and planets.

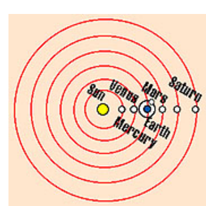
Two models of how the planets moved in space evolved over time.

Geocentric - Aristotle's Model



Assisted by Pythagoras and Euclid

Heliocentric - Copernicus' Model



Confirmed by Galileo and Kepler

Elliptical orbits

Satellites

Animation of each Model at http://www.astro.utoronto.ca/~zhu/ast210/both.html

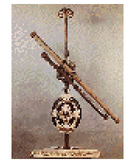
1.2 Discovery Through Technology

Imagination, and improvements in observation instruments and tools, advanced **Ancient Astronomy** into a more precise scientific understanding of the heavens.http://www.vedicobservatory.org/YPreface.html

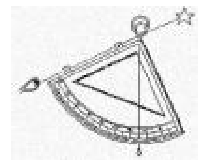
Looking with the naked eye

The earliest astronomers used several tools to chart the position of objects in the sky and to predict where the sun, moon, and certain stars would move. With the heavens serving as both timekeeper and navigational aid, such knowledge was of much more than scholarly interest.

Early Telescope - Before 1609, when Galileo began using a brand new invention called the telescope, humankind's perception of the cosmos was limited to what could be seen with the naked eye. It was natural to perceive Earth as the center of the universe, with a transparent, starry sphere rotating around it.



Quadrant - Tycho Brahe was an observation genius in astronomy before the age of the telescope. The mural, or Tychonian, quadrant was actually a very large brass quadrant, affixed to a wall. Its radius measured almost two meters and was graduated in tens of seconds. Sightings were taken along the quadrant through the small window in the opposing wall, to which Tycho points. The clock shown at the bottom right, accurate to seconds, allowed the observers to note the precise moment of observation.

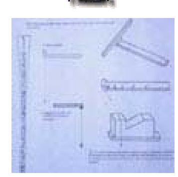


Armillery Sphere - was used to locate celestial objects As measuring devices became more and more precise, old notions about the universe began to crumble. For example, Brahe's measurements--even though they were made with the naked eye--were fine enough to reveal that comets move through the same region of space as the planets. That destroyed the idea that planets occupied a special place that no other object could penetrate.

Astrolabe - The astrolabe is the instrument used to observe the stars and determine their position on the horizon. It had two parts. The back had a moveable sighting arm and a scale for measuring altitude, while the front had a map of the heavens that helped to calculate the future position of objects. With this device, astronomers and others could predict when the sun and certain bright stars would rise or set on any given day. Ipparch invented the astrolabe in the 2nd century B.C. Ptolemy used the astrolabe as a type of geographical map. They were later used to tell time. In the Middle Ages the astrolabe was the main instrument for navigation later to be replaced by the sextant. At the beginning of the 20th century the prismatic astrolabe appeared, enabling the rays of a celestial body to be reflected onto a mercury surface to determine the point in time that it reached a certain height on the horizon.

Sextent - A sextant is a tool for measuring the angular altitude of a star above the horizon, which was usually the sun. Primarily, they were used for navigation. This instrument can be used to measure the height of a celestial body from aircraft, spacecraft or the ship's deck. The main types are the sextant used for ships and the bubble sextant used only on aircraft. How to use a sextent

Merket - Babylonian observations (1500 BC) recorded solar and lunar eclipses as well as planetary observations using markets.



Cross-staff - The cross-staff was made up of a straight staff, marked with graduated scales, with a closefitting, sliding crosspiece. The navigator rested the staff on his cheekbone and lined up one end of the moving crosspiece with the horizon and the other end with the bottom of the pole star, or the sun at midday. The position of the cross piece on the staff gave the reading of altitude.

The **astronomical unit** is used for measuring 'local' distances in the solar system. It is equal to the distance from the center of the Sun to the center of the Earth (approximately 149,599,000 kms).

A **light year** is equal to the distance light travels in 1 year (approximately 9.5 trillion kms). It is used for longer distances - to stars and galaxies. The distance to our nearest star, Proxima Centauri is a little over 4 light years.

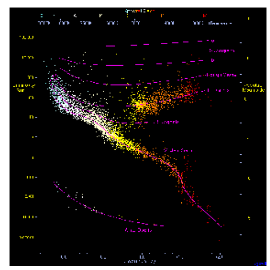
A **parsec** is a basic unit of length for measuring distances to stars and galaxies, equal to 206,265 times the distance from the earth to the sun, or 3.26 light-years, The nearest star, Proxima Centauri is about 1.31 parsecs from the Earth.

Looking Into The Past
When you view an object in the sky you are seeing it as it was in the past. It has taken the light a very long time to reach the Earth. Light from the Sun takes about 5 minutes to reach the Earth, whereas light from Pluto takes about 5 hours. The farther away, the longer light takes to reach the Earth. Light from the stars in the center of the universe takes about 25,000 years to reach the Earth. The Hubble telescope is capturing light from 12 billion years ago.

1.3. The Distribution of Matter in Space

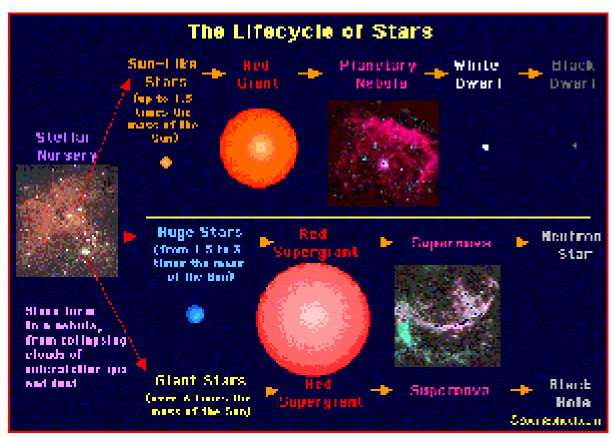
A star is a hot, glowing ball of gas (mainly hydrogen) that gives off light energy. Stars vary in their characteristics. Very hot stars look blue, while cooler stars look red. In the 1920's, **Ejnar Hertzsprung and Henry Norris Russell** compared the surface temperature of stars with its brightness (luminosity).

Stars fall into distinct groupings.



They graphed their data to show the relationship between brightness and temperature of stars was not random.

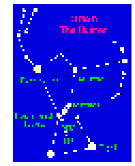
Birth of Stars (Great site showing an animation of how a star is born)



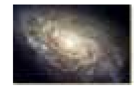
Stars form in regions of space where there are huge accumulations of gas and dust called nebulae.Interstellar matter, which makes up part of the nebulae, originated from exploding stars.The process of 'star-building' is known as fusion, which releases great amounts of energy and radiation.

A detailed explanation is provided on p. 387 in the textbook, and the link provided gives visuals that help to explain this life cycle.

Star Groups



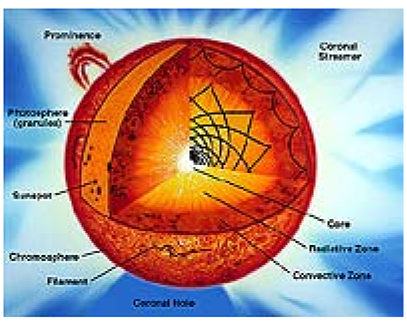
Constellations are the groupings of stars we see as patterns in the night sky. There are 88 constellations and many are explained in Greek Mythology. **Asterisms** are also groupings of stars but are not officially recognized as constellations.



Galaxies
A galaxy is a grouping of millions or billions of stars, gas and dust. It is held together by gravity. The **Milky Way Galaxy** is the galaxy our solar system is a part of. It is shaped like a flattened pinwheel, with arms spiraling out from the center.
(Map of the Milky Way)

Black holes are actually invisible to telescopes. Their existence is only known by an indirect method - when celestial material comes close to a black hole it becomes very hot and very bright.

1.4. Our Solar Neighbourhood



The **Sun** emits charged particles in all directions. This solar wind bombards the Earth at 400km/s, but the magnetic field of the Earth protects us.

Planet summary cards (spreadsheet) provides the information you need to review.http://www.edquest.ca/Notes/sia9-51-4planets.doc

The formation of our solar system is based on the '***protoplanet hypothesis***', which follows three steps:

1. A cloud of gas & dust in space begin swirling
2. Most of the matter (more than 90% of it) accumulates in the center - forming the Sun
3. The remaining materials accumulate (forming planets) and circle the Sun

Recent Histories of the Origins of the Solar System Hypotheses

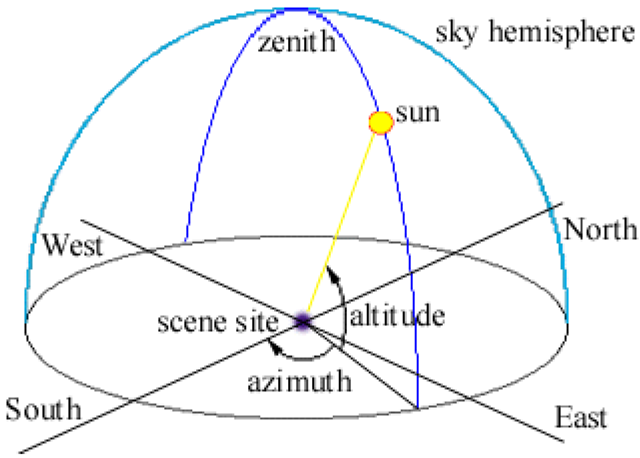
Other Bodies In Space (Use the cards prepared for you to review)

Tracking Objects In The Solar System

Elliptical paths can help Astronomers and scientists to trace and predict where bodies in space are, have been and will be in the future. The understanding of orbits has led to the discovery of many different comets. **NASA** tracks asteroids, comets and meteors that have been discovered by observatories and amateur astronomers.

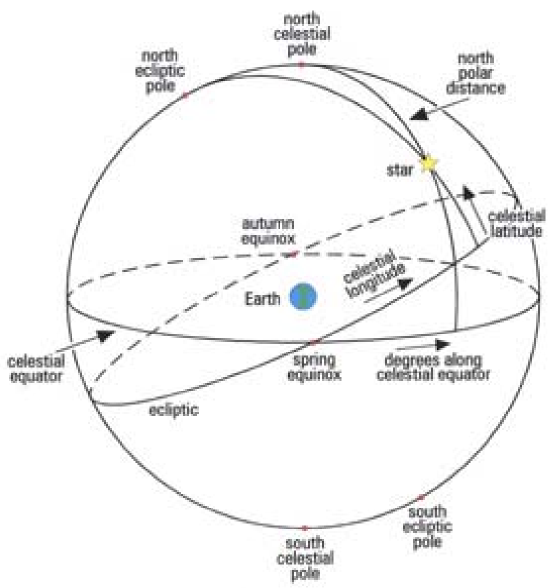
1.5. Describing the Position of Objects in Space

Altitude and Azimuth are calculated from the observer's position:



Altitude gives you the "how above the horizon it is"; the point straight overhead has an altitude of +90 degrees; straight underneath, an altitude of -90 degrees. Points on the horizon have 0 degree altitudes. An object halfway up in the sky has an altitude of 45 degrees. **Azimuth** determines "which compass direction it can be found in the sky." An azimuth of zero degrees puts the object in the North. An azimuth of 90 degrees puts the object in the East. An azimuth of 180 degrees puts the object in the South, and one of 270 degrees puts the object in the west. **Zenith** is the position in the sky directly overhead.

Thus, if Guide tells you that an object is at altitude 30 degrees, azimuth 80 degrees, look a little North of due East, about a third of the way from the horizon to the zenith. Java script applet: http://www.kemi.fi/kk021498/Java/sunapplet.html



The path in the sky along which the Sun takes is called the **ecliptic**.

The **Celestial Sphere** is the name given to the very large imaginary 'sphere of sky' surrounding the Earth.

http://www.ortelius.de/kalender/basic_en.php