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)

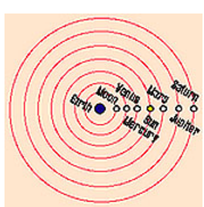
- The **Ancient Celts** set up megaliths, in concentric circles, at **Stonehenge** to mark the winter and summer solstices.
- **Ancient African cultures** set large rock pillars into patterns to predict the timing of the solstices as well.

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.

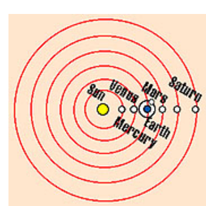
Two models of how the planets moved in space evolved over time.

Geocentric - Aristotle's Model



Assisted by Pythagoras and Euclid

Heliocentric - Copernicus' Model



Confirmed by Galileo and Kepler

Elliptical orbits

Satellites

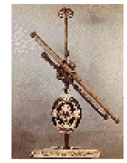
Animation of each Model at http://www.astro.utoronto.ca/~zhu/ast210/both.html

1.2 Discovery Through Technology

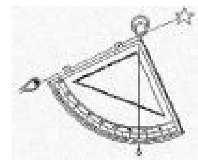
Imagination, and improvements in observation instruments and tools, advanced **Ancient Astronomy** into a more precise scientific understanding of the heavens.http://www.vedicobservatory.org/YPreface.html

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.

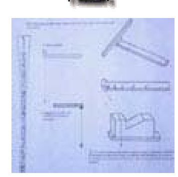


Quadrant - Tycho Brahe was an observation genius in astronomy before the age of the telescope. The mural, or Tychonian, quadrant was actually a very large brass quadrant, affixed to a wall. Its radius measured almost two meters and was graduated in tens of seconds. Sightings were taken along the quadrant 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.

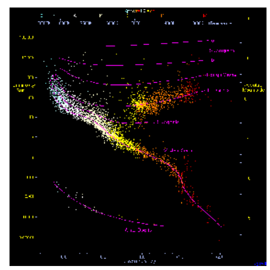
A **parsec** is a basic unit of length for measuring distances to stars and galaxies, equal to 206,265 times the distance from the earth to the sun, or 3.26 light-years, The nearest star, Proxima Centauri is about 1.31 parsecs from the Earth.

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

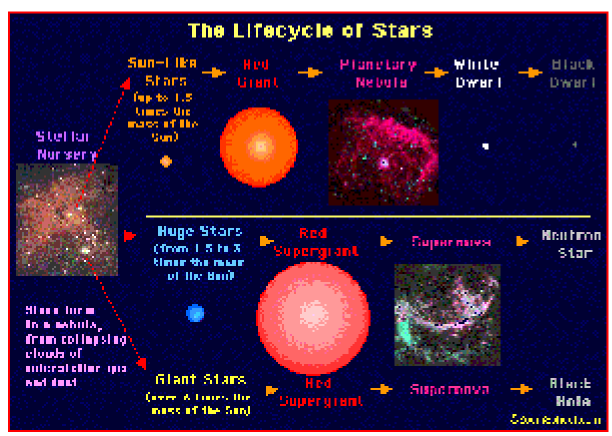
A star is a hot, glowing ball of gas (mainly hydrogen) that gives off light energy. Stars vary in their characteristics. Very hot stars look blue, while cooler stars look red. In the 1920's, **Ejnar Hertzsprung and Henry Norris Russell** compared the surface temperature of stars with its brightness (luminosity).

Stars fall into distinct groupings.



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

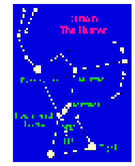
Birth of Stars (Great site showing an animation of how a star is born)



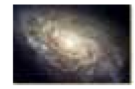
Stars form in regions of space where there are huge accumulations of gas and dust called nebulae.Interstellar matter, which makes up part of the nebulae, originated from exploding stars.The process of 'star-building' is known as fusion, which releases great amounts of energy and radiation.

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



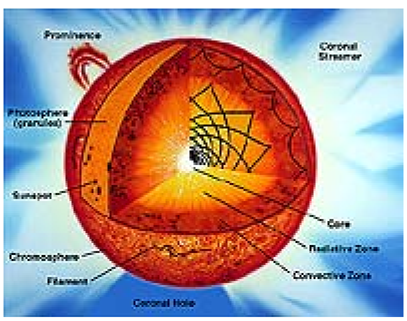
Constellations are the groupings of stars we see as patterns in the night sky. There are 88 constellations and many are explained in Greek Mythology. **Asterisms** are also groupings of stars but are not officially recognized as constellations.



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

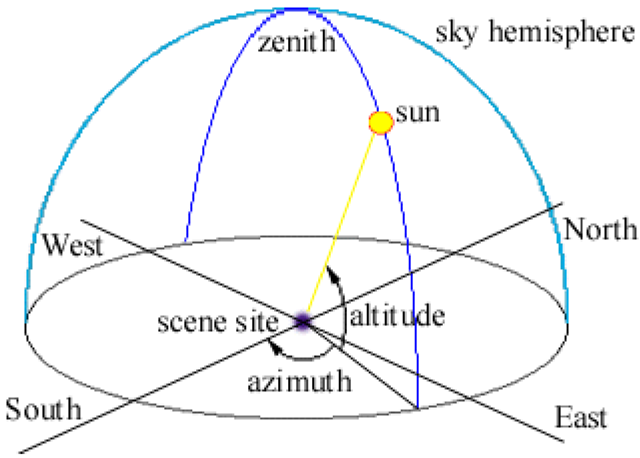
Other Bodies In Space (Use the cards prepared for you to review)

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.

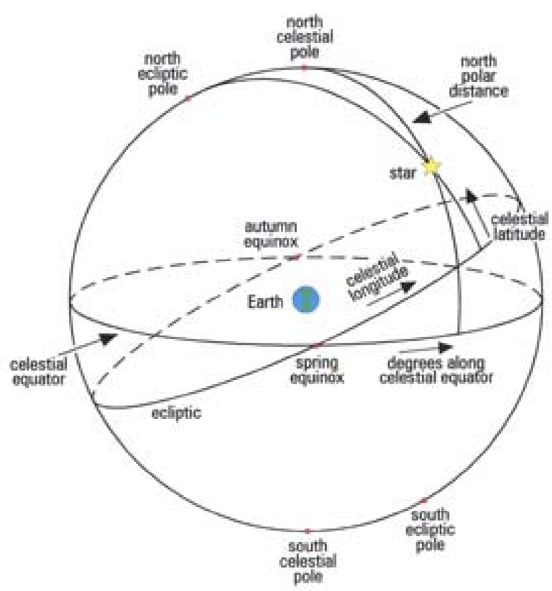
1.5. Describing the Position of Objects in Space

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

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

2.0 Technological developments are making space exploration possible and offer benefits on Earth.

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

2.1 Getting There: Technologies For Space Transport

The ***gravitational escape velocity*** had to be achieved (**28,000 km/h**), if humans were to venture into space.

The Achievements of Rocket Science
http://www.grc.nasa.gov/WWW/K-12/TRC/Rockets/history_of_rockets.html

(History of Satellites) http://inventors.about.com/library/inventors/blsatellite.htm
(Space Transport Firsts)) http://www.tbs-satellite.com/tse/online/thema_first.html

400 B.C	- Archytas used escaping steam to propel a model pigeon along some wires
1st Century	- Chinese used gunpowder to propelled 'flaming arrows'
17th Century	- Polish General uses solid fuel rockets in war
Early 1900's	- Konstantin Tsiolkovskii suggested liquid fuel be used for rockets
1920's	- Wernher Von Braun developed the V-2 rocket for war
1926	- Robert Goddard launched the world's first liquid-propellant rocket.
Oct. 4, 1957	- Sputnik was launched by the Russians
Nov, 1957	- Laika (a dog) survived in Earth orbit for 7 days
1961	- Explorer I launched by USA
1962	- Alouette launched by Canada
1969	- First man on the moon
1981	- First launch of the Shuttle

The Science of Rocketry
The science of rocketry relies on a basic physics principle that you learned in Grade 7.

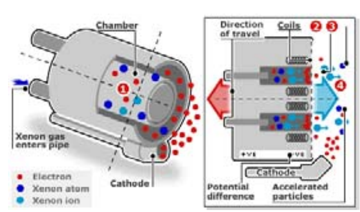
For every action – There is an equal and opposite reaction

There are three basic parts to a Rocket:
http://www.grc.nasa.gov/WWW/K-12/airplane/rktparts.html

- The **structural and mechanical elements** are everything from the rocket itself to engines, storage tanks, and the fins on the outside that help guide the rocket during its flight.
- The **fuel** can be any number of materials, including liquid oxygen, gasoline, and liquid hydrogen. The mixture is ignited in a combustion chamber, causing the gases to escape as exhaust out of the nozzle.
- The **payload** refers to the materials needed for the flight, including crew cabins, food, water, air, and people.

The Future of Space Transport Technology

Ion Drives are engines that use xenon gas instead of chemical fuel. The xenon is electrically charged, accelerated, and then released as exhaust, which provides the thrust for the spacecraft. The thrust is 10 times weaker than traditional engine fuels, but it lasts an extremely long time. The amount of fuel required for space travel is about 1/10 that of conventional crafts.



Solar Sail Spacecraft use the same idea as sailboats. They harness the light of the Sun. The Sun's electromagnetic energy, in the form of photons, hits the carbon fibre solar sails, and is transmitted through the craft to propel it through space. These spacecraft could travel up to 5 times faster than spacecraft today.

Shuttles	Space Probes	Space Stations
		
Shuttle Launch	**Mariner 10**	**International Space Station**
Shuttles transport personnel and equipment to orbiting spacecraft	Space probes contain instrumentation for carrying out robotic exploration of space	Space Stations are orbiting spacecraft that have living quarters, work areas and support systems to enable personnel to live in space for extended periods

The Next Step

Manned interplanetary space missions, possibly to Mars or Jupiter (one of it's Moons), or the colonization of the moon are ideas that have surfaced recently. Building a remote spacecraft-launching site (on the Moon, or on the International Space Station) is the first step to enable interplanetary flight to become a reality and will reduce the cost dramatically. As more space stations are built the reaches of space will soon be within our grasp.
Private developers and companies are even planning tourist flights and possibly hotels and amusement parks in space, or, on the Moon.

2.2 Surviving There: Technologies For Living In Space

To survive in space (which is a cold vacuum), technologies have needed to be developed to overcome the hazards of this harsh environment. A manned flight to Mars would last 2 to 3 years, which is a long time to be in an enclosed environment.

Hazards Of Living In Space

Environmental Hazards

Space is a vacuum with no air or water. Cosmic and solar radiation, and meteoroids are the greatest dangers. Because there is no atmosphere, the temperatures in space have both extremes– from extremely hot, to extremely cold. There is also no atmospheric pressure to help regulate the astronaut's heartbeats.

Psychological Challenges to Confined Living

Long trips can present psychological difficulties, as can the claustrophobic feeling of such tight living conditions.

The Body and Microgravity

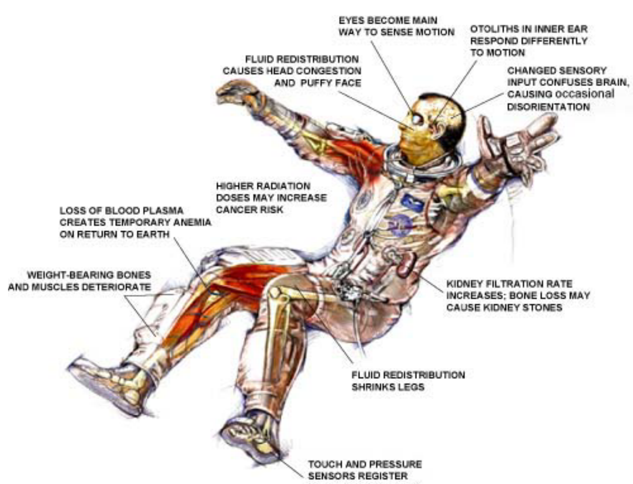
Living in microgravity can cause problems because of the effects of weightlessness on the human body.

Bones have less pressure on them and so they expand. They also lose calcium and become more brittle.

The heart doesn't have to pump as hard to circulate blood.

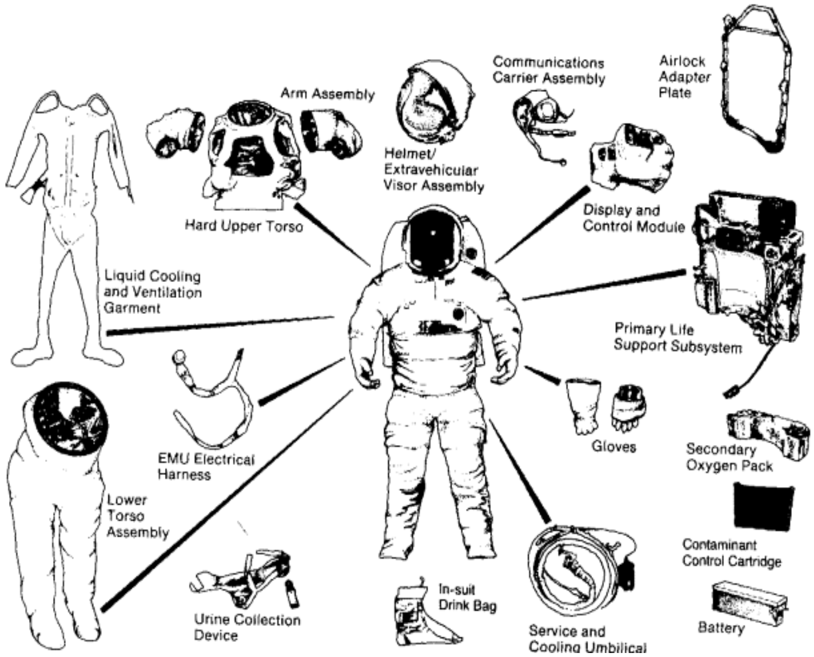
Muscles weaken and shrink.

Depth perception is also affected.



The Space Suit

The space suit is a mobile chamber that houses and protects the astronaut from the hostile environment of space. It provides atmosphere for breathing and pressurization, protects from heat, cold, and micrometeoroids, and contains a communications link.



The suit is worn by the astronauts during all critical phases of the mission, during periods when the command module is not pressurized, and during all operations outside the command and lunar modules whether in space, in the International Space Station, or on the moon.

A Home In Space
Outside Earth's atmosphere, life-support systems have to be artificially produced. Clean water, fresh air, comfortable temperatures and air pressure are essential to life. All these support systems, including a power supply to operate them, must be operational on the Space Station at all times.

Recycling Water

Almost 100% of the water in the station must be recycled. This means that every drop of wastewater, water used for hygiene, and even moisture in the air will be used over and over again. Storage space is also a problem, making recycling essential for survival.
The main functions of the life-support systems include:

- Recycling wastewater
- Using recycled water to produce oxygen
- Removing carbon dioxide from the air
- Filtering micro-organisms and dust from the air
- Keeping air pressure, temperature and humidity stable

Producing Oxygen

Electrolysis of water (remember H_2O can be split into hydrogen and oxygen). The astronauts use the oxygen and the hydrogen is vented into space.

Learn what it takes to be an astronaut, by reading **Dr. Roberta Bondar's** story on p. 426 in the **Science In Action 9** textbook.

2.3 Using Space Technology To Meet Human Needs

Satellites

Satellites can be **natural** – small bodies in space that orbit a larger body (the moon is a satellite of the Earth), and they can be **artificial** – small spherical containers loaded with electronic equipment, digital imaging and other instruments that are launched into Earth's orbit to perform one of four functions:

Communication Satellites

These satellites provide 'wireless' technologies for a wide range of applications. Digital signals have resulted in clearer communications and more users. **Anik 1** (launched by Canada in 1972) transmitted the first television broadcasts by satellite.

Satellites for Observation and Research

A ***geosynchronous*** orbit is one that enables a satellite to remain in a fixed position over one part of the Earth, moving at the same speed as the Earth. Numerous applications are now possible including:

- Monitoring and forecasting weather
- **LANDSAT** and **RADARSAT** (*are not in geosynchronous orbit*) – follow ships at sea, monitor soil quality, track forest fires, report on environmental change, and search for natural resources.
- Military and government surveillance

Remote Sensing

Those satellites in low orbits perform remote sensing – a process in which digital imaging devices in satellites make observations of Earth's surface and send this information back to Earth. The activities include providing information on the condition of the environment, natural resources, effects of urbanization and growth. This information is usually used for planning purposes.

Satellites as Personal Tracking Devices (GPS)

The **Global Positioning System** (**GPS**) allows you to know exactly where you are on the Earth at any one time. The system involves the use of **24** GPS satellites positioned in orbit, allowing for **3** to always be above the horizon to be used at any one time. The three GPS satellites provide coordinated location information, which is transmitted to a GPS receiver (hand-held) to indicate the person's exact position on the Earth.

"Space Age" Inspired Materials And Systems

Many materials that were originally designed for a space application have practical applications on the Earth. These are called '**spin-offs**'.

The table of '**spin-offs**' on p. 431 provides some examples in the fields of computer technology, consumer technology, medical and health technology, industrial technology, transportation technology, and public safety technology.

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

3.0 Optical telescopes, radio telescopes, and other technologies advance our understanding of space..

http://cdsweb.u-strasbg.fr/astroweb/optical.html
http://www.cv.nrao.edu/fits/www/yp_optical.html

3.1 Using Technology to See the Visible

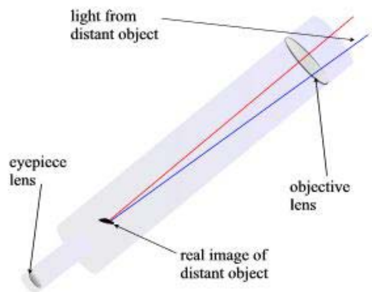
Telescopes allow us to see objects that are very distant in space.

Optical Telescopes

In 1608, Hans Lippershey made one of the first telescopes – but it was Galileo Galilei who made practical use of it. Optical telescopes are 'light collectors'. The series of lenses or mirrors enable the optical device to collect and focus the light from stars.

There are two types of optical telescopes:

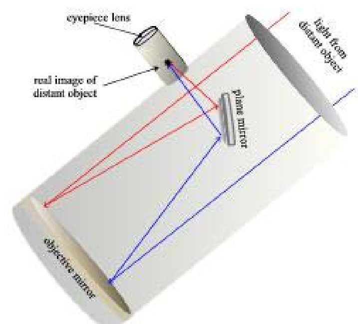
The first telescope designed was a simple **refracting telescope**. It uses two lenses to gather and focus starlight



There is also a limit to the size of lens that a refracting telescope can have. Diameters over 1 meter will cause the lens to warp.

Review Optical Telescopes Notes
Grade 8 Science Focus
Topic 5: Extending Human Vision
http://www.edquest.ca/Notes/3-5(8).html

Reflecting telescopes use mirrors instead of lenses to gather and focus the light from the stars. A process called 'spin-casting' today makes mirrors, by pouring molten glass into a spinning mould. The glass is forced to the edges, cooled and solidified. Mirrors as large as 6m across have been made using this method.



One of the newest innovations for ground-based optical reflecting telescopes is the use of **segmented mirrors** (a segmented-mirror telescope uses several lightweight-segments to build one large mirror).

Interferometry: Combining Telescopes For Greater Power

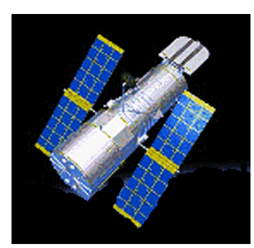
The technique of using a number of telescopes in combination is called interferometry. When working together, these telescopes can detect objects in space with better clarity and at greater distances than any current Earth-based observatory.
http://www.space.com/scienceastronomy/astronomy/interferometry_101.html

The Hubble Space Telescope (HST)

http://hubble.nasa.gov/
http://hubblesite.org/newscenter/

Hubble Facts:
http://hubblesite.org/reference_desk/facts_.and._figures/

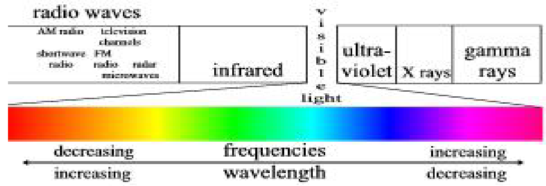
*The **HST** makes one complete orbit of the Earth every 95 minutes.*



To improve the views of space, astronomers are able to access images from a telescope in space. Free from the interferences of weather, clouds humidity and even high winds, the **Hubble Space Telescope**, launched in 1990, orbits 600 kms above the Earth, collecting images of extremely distant objects. It is a cylindrical reflecting telescope, 13 m long and 4.3 m in diameter. It is **modular** (parts can be removed and replaced) and is serviced by shuttle astronauts.

3.2 Using Technology to See Beyond the Visible

Besides the visible light that optical telescopes can give us, other forms of **electromagnetic energy** can also give us information about objects in space.



This energy travels at the speed of light, but has different wavelengths and frequencies from those of visible light. Energy with a short wavelength has a high frequency. Gamma rays are the most dangerous and radio waves are the safest. Visible light is measured in micrometers with 1 micrometer equal to 1 millionth of a meter.

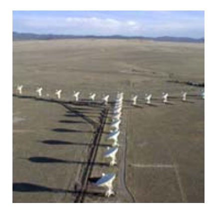
Radio Telescopes

Radio waves are received from stars, galaxies, nebulae, the Sun and even some planets. With the development of **radio telescopes**, astronomers gain an advantage over optical telescopes, because they are not affected by weather, clouds, atmosphere or pollution and can be detected day or night. Much information has been gained about the composition and distribution of matter in space, namely neutral hydrogen, which makes up a large proportion of matter in our Milky Way galaxy. Radio telescopes are made of metal mesh and resemble a satellite dish, but are much larger, curved inward and have a receiver in the center.

Radio telescope in Arecibo, Puerto Rico.

Radio Interferometry

By combining several small radio telescopes (just like they do with optical telescopes) greater resolving power can be achieved. This is referred to as **radio interferometry**, improving the accuracy and performance of the image in making radio maps. The greater the distance between the radio telescopes the more accurately they can measure position.
Arrays, like the *Very Large Array* in Sorocco, New Mexico, which uses **27** telescopes arranged in a **Y**, can improve accuracy even more.



Viewing More Than What The Eye Can See

Ultraviolet radiation is absorbed by the atmosphere and therefore cannot be studied very well from Earth. A distant planet orbiting a distant star cannot be seen because of the bright light from its star. However, when viewed in the infrared spectrum through a radio telescope, the stars brightness dims and the planets brightness peaks. The Keck Observatory in Hawaii is actively searching for planets, with its radio telescope. Other discoveries include fluctuations in microwave energy left over from the formation of the universe; X-rays emitted from black holes and pulsating stars; and huge bursts of gamma rays appearing without warning and then fading just as quickly.

Space Probes

Observation equipment is sent out into space to explore distant areas of our solar system. **Space probes** are unmanned satellites or remote-controlled '*landers*' that put equipment on or close to planets where no human has gone before. Probes have done remote sensing on Mercury and Jupiter, taken soil samples on Mars, landed on Venus, and studied Saturn's rings up close. (See chart in **SIA** p. 444).

The most recent probes to explore Mars are still there. They are **Spirit** and **Opportunity**. They are looking for evidence of water to determine if Mars at one time could have sustained life.

The only place that has been explored by humans in space, other than our Earth is the Moon. **Apollo 11** was the first landing and there have been many others since. The next step is to establish a base for interplanetary manned missions to **Mars**. (*To boldly go where no human has gone before*)

3.3 Using Technology to Interpret Space

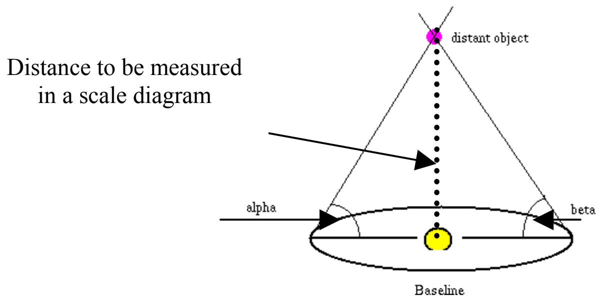
Measuring Distance

Triangulation and Parallax are two ways to measure distances indirectly, on the ground, or in space.

Triangulation

Triangulation is based on the *geometry of a triangle*. By measuring the angles between the **baseline** and a target object, you can determine the distance to that object.

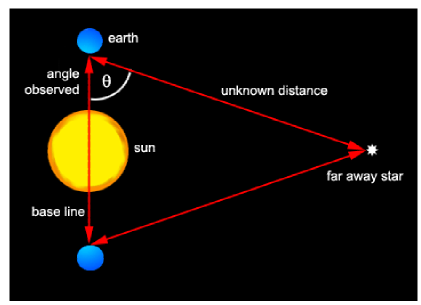
To measure the distance indirectly, you need to know the length of one side of the triangle (baseline) and the size of the angles created when imaginary lines are drawn from the ends of the baseline to the object.



There are two activities in the Textbook **p. 447, 448-449** that you can do to practice this skill.

Parallax

Parallax is the apparent shift in position of a nearby object when the object is viewed from two different places. Astronomers use a star's parallax to determine what angles to use when they triangulate the star's distance from the Earth. The larger the baseline, the more accurate the result. The longest baseline that astronomers can use is the diameter of Earth's orbit. Measurements have to be taken six months apart to achieve the diameter of the orbit.



Determining A Star's Composition

Astronomers refract the light from distant stars to determine what the star is made of. Stars have dark bands in distinct sequences and thicknesses on their spectra. Each element that is present in the star creates its own black-line 'fingerprint'. The spectra of the star is then compared to known spectra of elements to determine the star's composition. A **spectrometer** is used to do this.

Determining A Star's Direction Of Motion

A change in the pitch (frequency) of sound waves because they are stretched or squeezed is known as the **Doppler effect**. Changes in the sound waves can be measured to determine how fast and in what direction a light-emitting object is moving. The position of the dark bands is what shifts in the light waves of a moving star. The spectrum of an approaching star shows the dark bands shifting to the blue end of the spectrum, whereas, the shift is to the red part of the spectrum if a star is moving away from the Earth. The amount of shift indicates the speed at which the star is approaching or moving away. There are also practical applications that use the Doppler effect. Law enforcement officers detect the speed of an approaching vehicle by using a **radar gun**, which sends out a radio signal and receives one back from the vehicle. To determine the speed of the vehicle, the hand-held device records the difference in the outgoing wavelength and incoming wavelength.

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

4.0 Society and the environment are affected by space exploration and the development of space technologies.

4.1 The Risks and Dangers of Space Exploration

http://news.bbc.co.uk/1/hi/world/americas/2717535.stm

The dangers of the '*unfriendly to humans*' space environment were introduced in Section 2. Besides those dangers, there are others.

Accidents that may result in loss of life, economic setbacks and many years of work. There are tragedies that bring to life the true dangers of space travel, such as:

1967	1986	2003
– 3 astronauts of **Apollo 1** died during a training exercise	– 7 astronauts died when the **Space Shuttle Challenger** exploded shortly after launch	– 7 astronauts died when the **Space Shuttle Columbia** broke apart during re-entry
		

Other accidents or lost missions have occurred that have cost many millions of dollars and thousands of hours of work, including most recently, the European Rover on Mars – **Beagle**, that did not return any data, or signal, after it landed.

Sometimes decisions may have to be made that will ultimately determine if missions are to fail. **Apollo 11's** lunar (Moon) landing almost didn't occur, because the original landing site was found to be too rocky. With a precise amount of fuel, an alternate landing site had to be chosen on the first try, or the mission would be scrubbed.

The Dangers of Manned Space Travel

A launch can be affected by many dangers, including highly explosive fuel, poor weather, malfunctioning equipment, human error and even birds. Once in flight, the spacecraft can be affected by floating debris, meteoroids and electromagnetic radiation (coronal mass ejections – or, solar flares). Re-entering Earth's atmosphere also has it dangers (as proven by the Colombia disaster). The re-entry path the spacecraft takes must be perfect, otherwise, if it is too shallow - it will bounce off the atmosphere, and if it is too steep – it will burn-up.

Space Junk

Space junk refers to all the pieces of debris that have fallen off rockets, satellites, space shuttles and space stations that remain in space. This can include specks of paint, screws, bolts, nonworking satellites, antennas, tools and equipment that is discarded or lost.

The Hazards in Space

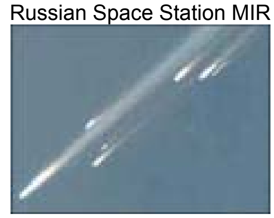
Over 4000 missions have been sent into space. **Micrometeorites** are constantly bombarding spacecraft and the International Space Station. They travel at extremely high velocity and can cause great damage. Once they enter the atmosphere, they usually burn up.

The Hazards on Earth

Some debris in space will enter the atmosphere and will not totally burn up. When this occurs, it may land in populated areas and cause loss of life or damage to property.

Some satellites, or decommissioned space stations, that re-enter the atmosphere have radioactive parts and can contaminate a very large area, costing a lot of money and hours to clean it up. Some burn up in the atmosphere and those parts that don't, can fall into the ocean, making recovery and clean-up less costly.

Russian Space Station MIR



Re-entry and burn-up

4.2 Canadian Contributions to Space Exploration and Observation

http://www.spacenet.on.ca/

Canadian Space Agency Website: http://www.space.gc.ca/asc/eng/default.asp

One of the most notable Canadian contributions to the international space program is the '**Canadarm**'.

It was launched in **1981** and has served a very useful purpose on many missions, including launching and retrieving satellites for use or repair, fixed the Hubble Telescope and put modules of the International Space Station together.

Canadarm 2 is currently operating as a vital part of the **International Space Station**. It has three main parts:

- *Remote manipulator system* – seven motorized joints, carries large payloads, assists with docking shuttles, moves around to different parts of the station.
- *Mobile base system* – can travel along a rail system to move to different parts of the station
- *Special purpose dexterous manipulator* – uses its two-armed robotic hands for delicate assembly work.

Canada has also launched satellites into orbit:

- **Alouette 1** in **1962** – one of the first satellites launched for non-military use
- **Anik 1** in **1972** – communications across the entire country
- **1973** – Canada was the 1st nation to broadcast television signals via satellite

Brief Summary of Canada's Contributions in Space:

- **1839** – Sir Edward Sabine establishes the 1st magnetic observatory and discovers that the Aurora Borealis is associated with sunspot activity
- **1962** – 3rd nation to launch a satellite
- **1969** – supplied landing gear for Apollo 11
- **1981** – **Canadarm 1** used for the first time in space
- **1984** – 1st astronaut – Marc Garneau
- **1992** – 1st female astronaut – Roberta Bondar
- **1997** – Technology for the **Mars Pathfinder Mission** - *Sojourner* rover ramp
- **2001** – Chris Hadfield - 1st Canadian to walk in space
  – he helped deliver the **Canadarm 2** to the **ISS**.

4.3 Issues Related to Space Exploration

http://adc.gsfc.nasa.gov/adc/education/space_ex/issues.html
http://www.spacelaw.com.au/content/issues.htm
http://adc.gsfc.nasa.gov/adc/education/space_ex/essay1.html

Should money be spent to explore space
or
Should it be used to fix the problems we have on the Earth?

The Pros and Cons Of Space Exploration

Disease, poverty, hunger, pollution and terrorism are all problems that face the people of the Earth. Spending billions to explore space, or spending billions to solve the conditions we currently experience is an ongoing debate that likely will never be solved. With depleting natural resources, population increases and advances in technology, the exploration of space may be the only option in the future.

The Potential Value Of Space's Resources

Resources in space mean economic wealth. Energy supplies appear to be unlimited – solar energy from the Sun and mineral resources from the Asteroid belt. The cost of travel in space could be cut substantially if fuel and construction material is readily available in space. The Moon is one of the first places scientists looked for resources where they were able to process hydrogen and oxygen from Moon rock. The oxygen could be used for life support and hydrogen for fuel on lunar bases. Combining the two, water can be produced.

Political, Ethical, and Environmental Issues

Political	Ethical	Environmental
Who owns space?	Is it right to spend so much on space, instead of fixing Earth's problems?	Who is responsible for protecting space environments from alteration?
Who can use the resources in space?	Do we have a right to alter materials in space to meet our needs?	Who is responsible for cleaning up space junk?
Who will determine what goes on in space?	How can we ensure that exploration will be used for good and not evil?	

Collaboration between nations with a '**space treaty**' may resolve some of these issues and pave the way to ensure that space exploration is orderly, meaningful and fair to all humans and all nations.