

UNIT LEARNING PACKS
FOCUS IN ACTION

Grade 9 Science In Action
Unit E - Space Exploration

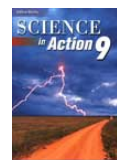
'Focus in Action' UNIT LEARNING PACKS

These booklets are designed to provide Grade 9 students with all the resources needed to review or reinforce concepts, covered in the Alberta Science Curriculum, and included in the Grade 9 Science Final Exam in June. There are circumstances in which **an entire unit** may be missed and covering the concepts from that unit (for the final exam) can be difficult. This can happen for a number of reasons:

- Students – new to the school – register throughout the year (from other provinces, school jurisdictions or countries)
- Students may be ill or have surgery and often can miss one or more units
- Students have extended holidays throughout the year
- Transfers from another school, who have completed the units in a different order

For additional support, students are directed to the **Edquest Middle School Science Website** or, Scienceman Resource (www.scienceman.com/scienceinaction/pgs/hot_9u5.html)

Unit 5 – Space Exploration



- **Section 1 Notes & Quiz**
- **Section 2 Notes & Quiz**
- **Section 3 Notes & Quiz**
- **Section 4 Notes & Quiz**
- **Unit Summary and Review Booklet**
(Covered in class, prior to the Final Achievement Exam)
- **Unit Test**
- **Answer Key for Section Quizzes and Unit Test**

Additional support will be provided, in the form of practice Achievement Test Questions, during the course review in June. Multiple Choice Questions and Numerical Response Questions will be reviewed, as these are the types that will make up the Science 9 Final Exam

Handouts and other activities, to reinforce the concepts covered in this Unit, will be made available based on need. If you require further information or resources, email Edquest directly: edquest@gmail.com.

Finding Solutions to Problems, instead of Making Excuses

Student Instructions for use of this Learning Pack

The purpose of this Learning Unit Pack is to provide you with the resources that will help you cover the material from the curriculum that will be tested on the Final Exam in June. Follow these steps to successfully complete this Unit Learning Pack:

Step 1 – Read the **Topic Notes**

Step 2 – Use a **highlighter** to identify the key words or phrases in the Topic Notes and reread the material again paying close attention to those words that you highlighted. If necessary, modify your highlights to make sure you understand the material in the notes.

Step 3 – Complete the **Topic Quiz**

Step 4 – Correct the Topic Quiz by **checking the answers** in the back of this Learning Pack.

Step 5 – Using your **textbook** and the **completed quiz**, find the page where the question and correct answer can be found and write it next to the question number in your Learning Pack.

Step 6 – **Repeat Steps 1-5** for each of the other Topics in this Unit.

Step 7 – Look over the **Unit Outline** to review the **Key Concepts** once you have completed all of the Topics.

Step 8 – Complete the **Unit Review**, using your **Learning Pack** and **Textbook**.

Step 9 – **Highlight** those sections of the Review that you had difficulty with and review those sections with your teacher prior to taking the Unit Test.

Step 10 – Take the **Unit Test** and correct it using the answer key provided in the back of the Learning Pack.

Step 11 – You should now be ready to answer any questions on the **Final Exam** related to this Unit.

Anything you still do not understand should be discussed with your teacher. Congratulations on your **Independent Study**, and Good Luck on the Final Exam. I hope you have made good use of this resource. Please provide feedback to your teacher, so that this resource can be improved.

Additional support is available in the form of practice Achievement Test Questions. **Multiple Choice Questions** and **Numerical Response Questions** will be made available on request, as these are the types that will make up the **Alberta Science 9 Achievement Exam**.

Handouts and other activities, to reinforce the concepts covered in this Unit may be acquired by visiting the Edquest Middle School Science Resource Website

<http://www.edquest.ca>

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.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

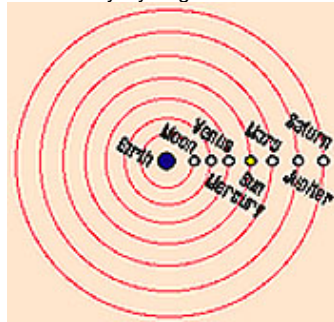
Autumnal equinox – occurs in the fall (*Northern hemisphere - Sept. 22*)

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.

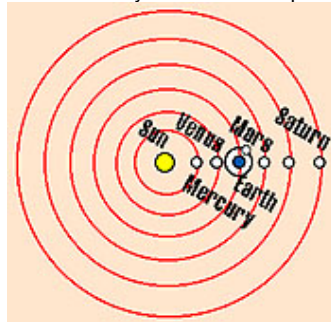
Ancient cultures tried to explain the motions of the stars and planets. Two models of how the planets moved in space evolved over time.

Aristotle's Model
Assisted by Pythagoras and Euclid



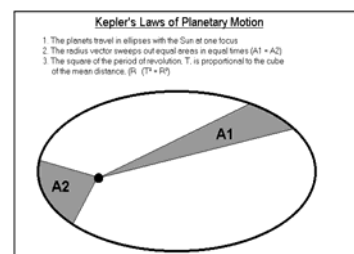
Geocentric

Copernicus' Model
Confirmed by Galileo and Kepler



Heliocentric

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.



Armillary 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.

Sextant

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 sextant](#)

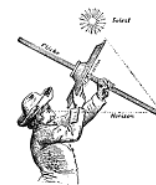


Sundial**Merket**

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

**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.

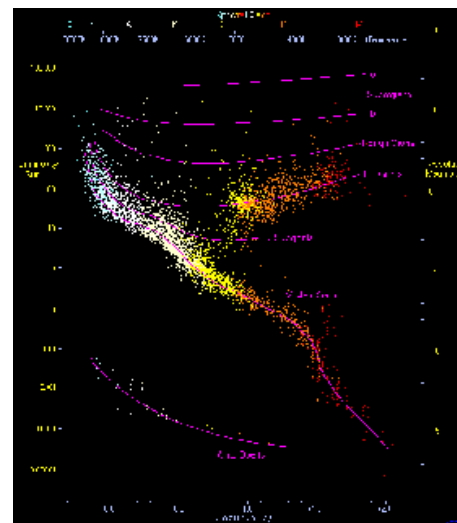
1.3. The Distribution of Matter in Space

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

Stars fall into distinct groupings.



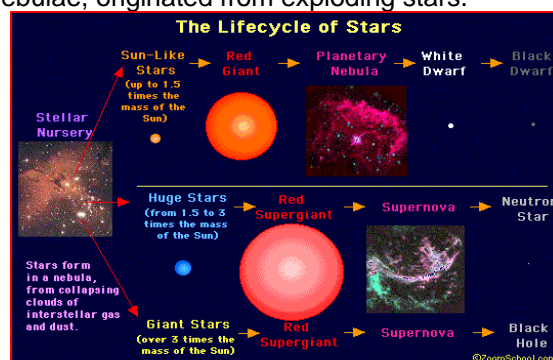
[Birth of Stars](#) (Great site showing an animation of how a star is born)

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.

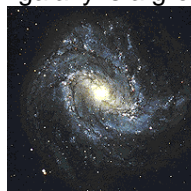


Star Groups

[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.

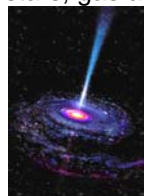
Galaxies

A galaxy is a grouping of millions or billions of stars, gas and dust. It is held together by gravity.



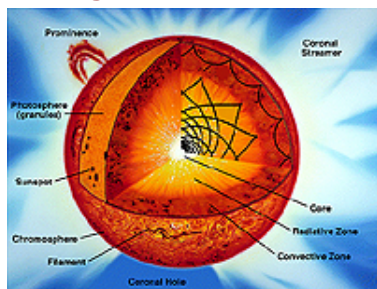
The [Milky Way Galaxy](#) is the galaxy our solar system is a part of. It is shaped like a flattened pinwheel, with arms spiraling out from the center.

([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.

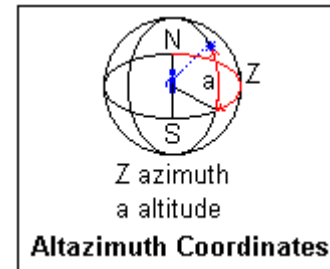
1.5. Describing the Position of Objects in Space

Altitude and **Azimuth** are calculated from the observer's (*the person in blue*) 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. 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.

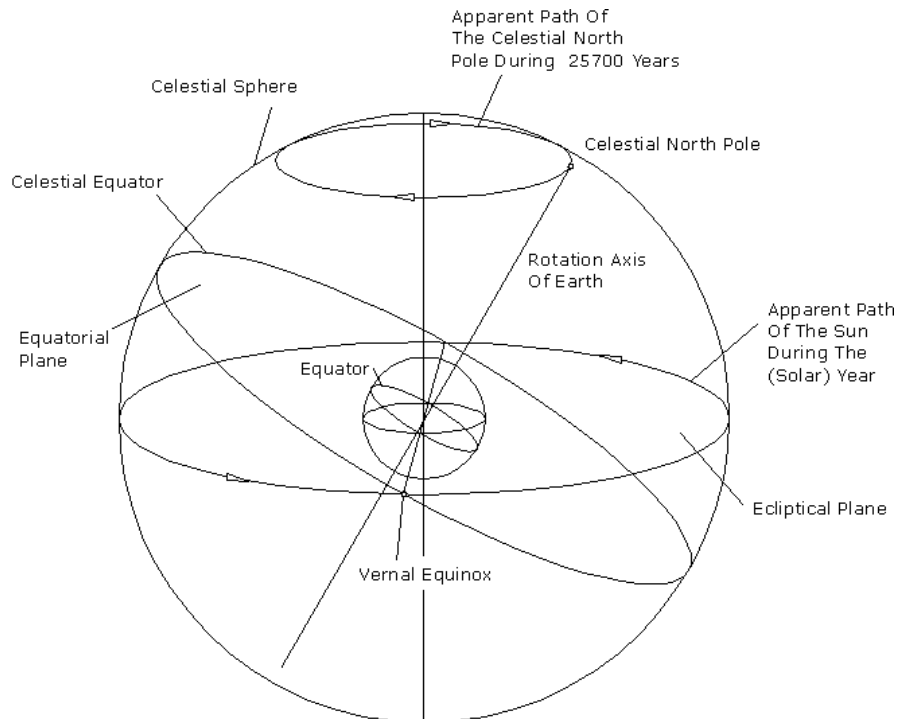
Java script applet: <http://www.kemi.fi/kk021498/Java/sunapplet.html>



Zenith is the position in the sky directly overhead.

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

1.1 Early Views About The Cosmos

1. Many dates in the celestial calendar are marked by the amount of daylight. In the Northern Hemisphere the longest day occurs on June 21 and is called ...
 - A. Vernal equinox
 - B. Autumnal equinox
 - C. Summer solstice
 - D. Winter solstice
2. The Mayans of Central America built an enormous cylinder-shaped tower at **Chichén Itzá** to celebrate the occurrence of the ...
 - A. solstices
 - B. equinoxes
 - C. Solar eclipse
 - D. Lunar eclipse
3. The width of a mitt was used by the **Inuit** peoples in the high Arctic to gauge the height of the Sun above the horizon. When it rose to one mitt-width high it meant ...
 - A. The days would get longer and warmer
 - B. The nights would get colder and shorter
 - C. Seal pups would be born in two lunar cycles
 - D. The Northern Lights would shine their brightest
4. Aristotle's proposed model of the solar system to explain planetary motion was the Geocentric Model. At the center was the Earth and ...
 - A. water
 - B. wind
 - C. fire
 - D. gas
5. Copernicus proposed a different model to explain planetary motion. His model, called the Heliocentric model. Galileo Galilei later confirmed his model, in his observations with one of the first telescopes. But it was this Johannes Kepler, who put in place what was missing from Copernicus' model. He realized that the orbits of the planets were ...
 - A. circular
 - B. geocentric
 - C. intersecting
 - D. ellipses

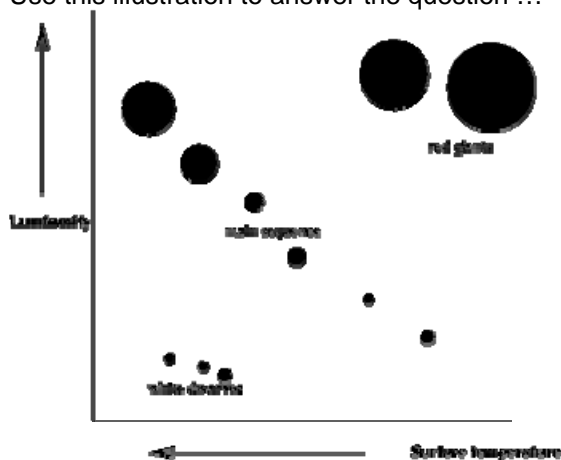
1.2 Discovery Through Technology

6. The unit used to measure 'local distances' in space (inside our solar system) is called an **astronomical unit**. One astronomical unit is equal to the average distance from the center of the Earth to the center of the Sun. The largest planet, Jupiter, is approximately ...
 - A. 5 AU's from the Sun
 - B. 10 AU's from the Sun
 - C. 19 AU's from the Sun
 - D. 30 AU's from the Sun
7. In the 2nd Century A.D. Egyptian astronomers used an instrument, called a **quadrant** to ...
 - A. measure the angle between the Moon and any given star
 - B. identify details in the far reaches of the night sky
 - C. chart astronomical position and predict the movement of stars
 - D. measure a star's height above the horizon

8. Arabian Astronomers used an instrument, called an **astrolabe** to ...
- measure the angle between the Moon and any given star
 - identify details in the far reaches of the night sky
 - Make accurate charts of star positions predict the movement of stars
 - measure a star's height above the horizon
9. The light from our sun takes about 5 minutes to reach the Earth. Light from the planet Pluto takes...
- 5 hours
 - 5 days
 - 5 weeks
 - 5 months
10. When measuring the diameter of the sun, we use an indirect method, so that we can determine the diameter without actually measuring it directly. To calculate the accuracy of your measured value, this is calculated to show how far from the real value your measured value is ...
- actual error
 - estimated error
 - percent error
 - adjusted error

1.3 The Distribution Of Matter In Space

11. In the 1920's two scientists began comparing the surface temperature of stars with the star's luminosity. They graphed their results in what is referred to as the ...
- Solar Shift Model
 - Hertzsprung-Russell Diagram
 - Wegener-Darwin Illustration
 - Helio-Solar Diagram
12. Use this illustration to answer the question ...



What they discovered when plotting their data was that ...

- star temperature and brightness was not random
- star temperature and size were related
- star brightness and size were related
- star size and shape were related to brightness

13. A star has a definite life cycle. The first stage in the star's formation is called ...
- A. **nebulae**
 - B. **dwarf**
 - C. **massive**
 - D. **protostar**
14. At the end of the life cycle of a star it explodes in a catastrophic event called a ...
- A. **massive**
 - B. **supergiant**
 - C. **black hole**
 - D. **supernova**
15. Astronomers are discovering these are more common than first thought. Although they are invisible to observers, using even the most powerful telescopes, Astronomers know of their existence because of how matter near it becomes very hot and bright. Because these bodies are so dense, even light cannot escape. They are called ...
- A. **Neutron Stars**
 - B. **Supernovas**
 - C. **Black Dwarfs**
 - D. **Black Holes**

1.4 Our Solar Neighborhood

16. Constellations are groupings of stars that we see as patterns. The International Astronomical Union recognizes 88 officially. There are other patterns that are unofficially recognized, such as The Big Dipper, and are known as ...
- A. **anomalies**
 - B. **asterisms**
 - C. **asteroids**
 - D. **aspergummies**
17. Solar winds pass the Earth at an average speed of 400 km/s. This protects us from the devastating effects of the solar winds ...
- A. **Earth's atmosphere**
 - B. **Earth's gravity**
 - C. **Earth's magnetic field**
 - D. **Earth's ozone**
18. Small pieces of rock that travel through space with no predictable or recognizable path are called ...
- A. **comets**
 - B. **asteroids**
 - C. **meteoroids**
 - D. **fragments**
19. During a solar eclipse this is visible ...
- A. **the sun's core**
 - B. **the sun's electromagnetic shield**
 - C. **the sun's atmosphere**
 - D. **the sun's corona**
20. The first spacecraft to successfully orbit and then land on an asteroid was
- A. **EUSA Beagle**
 - B. **NASA Opportunity**
 - C. **NEAR Shoemaker**
 - D. **FAR Eros**

1.5 Describing The position of Objects In Space

21. The direction directly overhead is called ...
- A. azimuth
 - B. altitude
 - C. zenith
 - D. astroplane
22. To locate an object in the sky, two questions must be solved. How high is it in the sky? and in what direction is it? The term that identifies the **compass direction** is ...
- A. azimuth
 - B. altitude
 - C. zenith
 - D. astroplane
23. When constructing an astrolabe to locate the position of a star in the night sky, the **protractor** is used to determine the ...
- A. azimuth
 - B. altitude
 - C. zenith
 - D. astroplane
24. The ancient Greeks studied the stars and the celestial bodies. They had a word that meant '**wanderer**' to describe a celestial body that changed its position in the sky. 'Wanderer' is the origin for the word
- A. Comet
 - B. Asteroid
 - C. Star
 - D. Planet
25. The imaginary '**sphere of sky**' showing the ecliptic (apparent path of the Sun through the sky during the year) that surrounds the Earth is identified as the ...
- A. Equinox sphere
 - B. Celestial sphere
 - C. Heavenly sphere
 - D. Solstice sphere

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

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

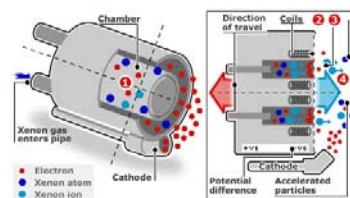
There are three basic parts to a Rocket:

<http://www.grc.nasa.gov/WWW/K-12/airplane/rktparts.html>

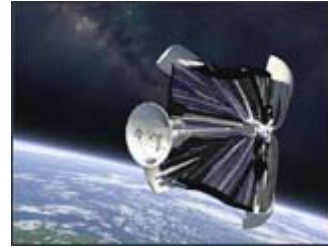
- The **structural and mechanical elements** are everything from the rocket itself to engines, storage tanks, and the fins on the outside that help guide the rocket during its flight.
- The **fuel** can be any number of materials, including liquid oxygen, gasoline, and liquid hydrogen. The mixture is 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

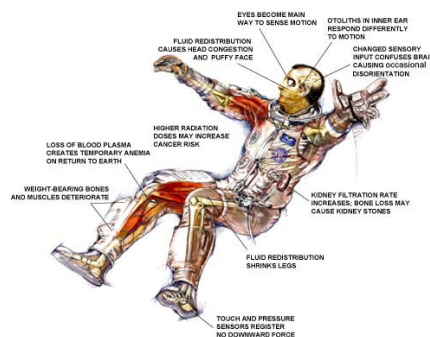
Living in microgravity can cause problems because of the effects of weightlessness on the human body.

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.

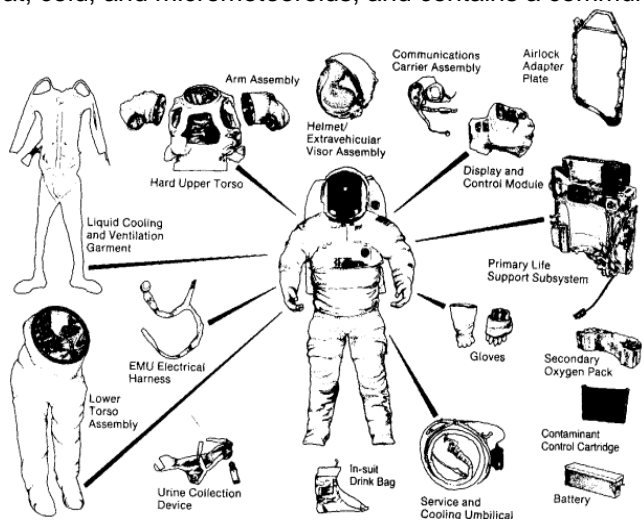
Muscles weaken and shrink.

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 H₂O 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.

2.1 Getting There: Technologies for Space Transport

1. Satellites transmit non-stop information for use in all of the following **EXCEPT...**
 - A. **communications**
 - B. **navigation**
 - C. **structural strength**
 - D. **weather forecasting**

2. The very first Rocketeer was a Chinese official, Wan-Hu. In the 16th century forty-seven rockets were attached to his chair and connected to two kites. After the rockets were ignited...
 - A. **Wan-Hu was lifted into orbit.**
 - B. **the explosion proved that rockets were reliable.**
 - C. **no traces of Wan-Hu, the chair, or the kites was found.**
 - D. **the rockets helped propel Wan-Hu into space and the kites kept him up there for 2 days.**

3. The first country to launch an artificial satellite was Russia. On October 4, 1947 they successfully launched a satellite called ...
 - A. **Freedom**
 - B. **Soyuz**
 - C. **Sputnik**
 - D. **Allouette**

4. The first living organism in launched into Earth orbit was Laika. He survived for seven days. Laika was a ...
 - A. **dog**
 - B. **cat**
 - C. **monkey**
 - D. **mouse**

5. The three basic parts to a rocket are the structural and mechanical elements, the fuel and the ...
 - A. **oxidizer**
 - B. **combustion chamber**
 - C. **nozzle**
 - D. **payload**

6. There are different alternative ways to power spacecraft. One of these alternatives is solar power. It is estimated that spacecraft with solar sails could travel 5 times faster than the conventional spacecraft. What do solar sails use for their propulsion?
 - A. **wind**
 - B. **heat**
 - C. **magnets**
 - D. **light**

7. The International Space Station is a joint venture of 16 countries. Private companies as well are planning to develop these in space, or on the Moon.
 - A. **Research centers**
 - B. **Resorts and historical holidays**
 - C. **Hotels and amusement parks**
 - D. **Construction and mining sites**

2.2 Surviving There: Technologies for Living In Space

8. All of the following are hazards of living in space, EXCEPT ...
 - A. **Environmental hazards**
 - B. **Psychological challenges to confinement**
 - C. **The body and microgravity**
 - D. **Food consumption and exercise**

9. In the condition of **weightlessness** the body undergoes many changes. Because bones have less pressure on them in this type of gravity, they ...
- A. **expand**
 - B. **shrink**
 - C. **get soft**
 - D. **become porous**
10. Almost 100% of all materials used on the International Space Station are recycled. The primary reason for this is because of ...
- A. **storage space**
 - B. **cost**
 - C. **energy use**
 - D. **time saving**

2.3 Using Space Technology to Meet Human Needs on Earth

11. Satellites are used for numerous purposes. A 'natural' satellite is any ...
- A. **thing orbiting the Earth**
 - B. **small body orbiting a larger body**
 - C. **large object that is put into orbit with rockets**
 - D. **object that communicates information back to Earth**
12. LANDSAT and RADARSAT are Canadian satellites that monitor ships at sea, soil quality, track forest fires, report on environmental change & search for natural resources. These satellites are **NOT** in ...
- A. **Earth orbit**
 - B. **geosynchronous orbit**
 - C. **use 24 hours a day**
 - D. **alignment with radar stations on the Earth**
13. Observation & research satellites are put into **geosynchronous** orbit. This means that they move ...
- A. **faster than the Earth spins**
 - B. **slower than the Earth spins**
 - C. **at the same rate as the Earth spins**
 - D. **twice as fast as the Earth spins**
14. GPS satellites enable you to find out your exact position on the Earth at any time. 24 GPS satellites are orbiting the Earth at all times. To use the GPS system you need to get a signal from ...
- A. **2 of them**
 - B. **3 of them**
 - C. **4 of them**
 - D. **6 of them**
15. Space Age materials are used on the Earth as well as in space. The improvement of traction on car winter tires is the result of an application that was originally developed for ...
- A. **parachute material for the Viking space mission**
 - B. **voice-controlled wheelchairs**
 - C. **structural analysis of a spacecraft**
 - D. **microlasers for communication**

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

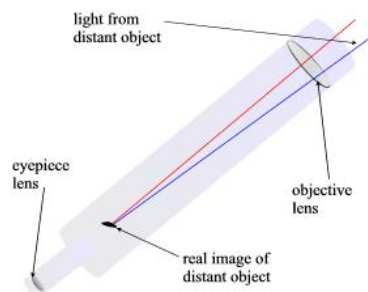
Telescopes allow us to see objects that are very distant in space.

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:

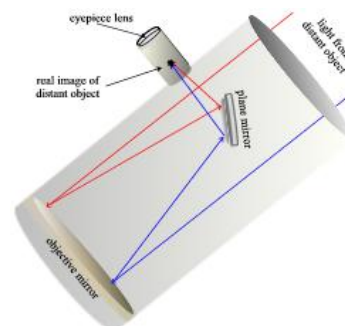
The first telescope designed was a simple **refracting telescope**. It uses two **lenses** to gather and focus starlight



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](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)

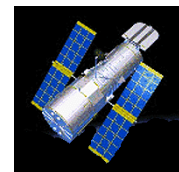
<http://hubble.nasa.gov/>

<http://hubblesite.org/newscenter/>

Hubble Facts:

http://hubblesite.org/reference_desk/facts_and_figures/

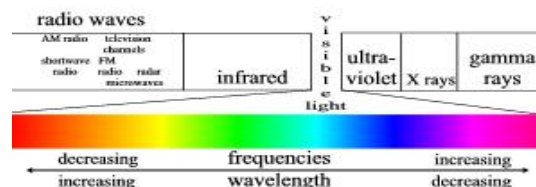
The HST makes one complete orbit of the Earth every 95 minutes.



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 Socorro, 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

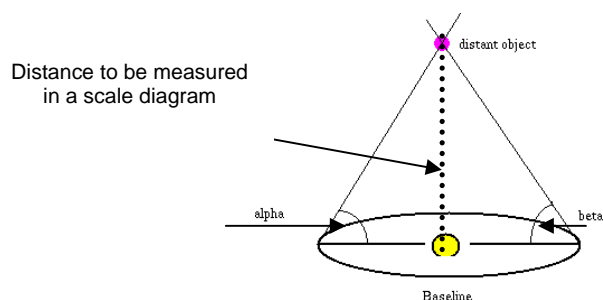
Measuring Distance

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.

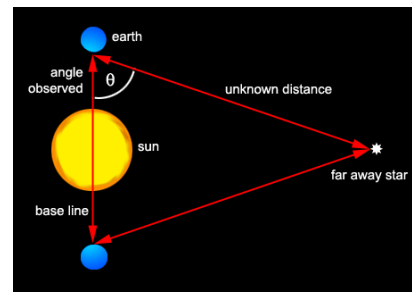
To measure the distance indirectly, you need to know the length of one side of the triangle (baseline) and the size of the angles created when imaginary lines are drawn from the ends of the baseline to the object.



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.

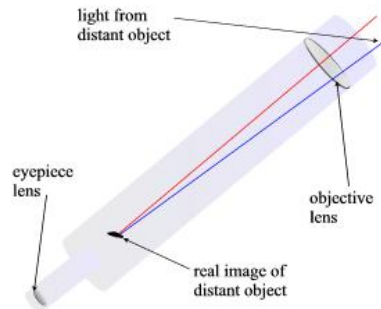
Determining A Star's Direction Of Motion

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.



3.1 Using Technology To See the Visible

1.



This type of telescope is a ...

- A. reflecting
 - B. refracting
 - C. complex
 - D. compound
2. To build bigger and better telescopes, builders use a method called ...
- A. spin casting
 - B. fly fishing
 - C. baiting
 - D. trolling
3. One of the newest innovations for ground-based optical reflecting telescopes is the use of ...
- A. metal instead of glass
 - B. liquid instead of glass
 - C. segmented mirrors
 - D. mirror arrays
4. **Interferometry** is a technique of using telescopes in combination. The advantage of using two or more telescopes together is that astronomers are able to ...
- A. work together
 - B. see more detail
 - C. hypothesize about images
 - D. create more colorful images
5. The **Hubble Space Telescope** offers a solution to the problems faced by astronomers on the Earth. Despite the remote mountain locations of ground-based telescopes to get away from light and air pollution, astronomers on the Earth still have to deal with interference caused by ...
- A. noise
 - B. aircraft
 - C. weather
 - D. earthquakes

3.2 Using Technology to See Beyond the Visible

6. Optical telescopes give us information based on visible light. However, objects in space, such as stars and galaxies, also emit many forms of electromagnetic energy. The energy form that has the longest wavelength is ...
- A. infrared
 - B. gamma
 - C. x-ray
 - D. radio

7. The electromagnetic spectrum identifies the many forms of electromagnetic energy. We can only see the visible light, but bees and other insects can see this form of electromagnetic energy ...
- A. x-rays
 - B. infrared
 - C. ultraviolet
 - D. microwaves
8. Although **neutral hydrogen** (which makes up a large bulk of matter in space) emits no light, it does emit energy at a specific wavelength. Astronomers are able to map out this neutral hydrogen in our Milky Way galaxy by using these types of telescopes ...
- A. radio telescopes
 - B. infrared telescopes
 - C. refracting telescopes
 - D. interferometry telescopes
9. Radio Interferometry, the combinations of many radio telescopes enables astronomers to improve performance and accuracy of images. They can more accurately measure position if they are ...
- A. at a higher altitude
 - B. closer to sea level
 - C. closer together
 - D. further apart
10. Another way to get information about distant objects in space is to send out a **space probe**. These probes are unmanned satellites, or remote-controlled 'landers' that place equipment close to a place where humans have not been able to get to. '*Spirit*' and '*Opportunity*' are two probes that have recently been sent by **NASA** to get information about ...
- A. Mercury
 - B. Mars
 - C. Titan (Jupiter's moon)
 - D. Comet Halle-Bop

3.3 Using Technology to Interpret Space

11. If you have a baseline and know the angles to an object - an unknown distance away - you can accurately determine its actual distance away by using this method ...
- A. trigonometry
 - B. interferometry
 - C. triangulation
 - D. base ten math
12. **Parallax** is the *apparent shift in position of a nearby object when the object is viewed from two different positions*. Astronomers use a star's parallax to determine ...
- A. what angles to use when they triangulate the star's distance from Earth
 - B. it's orbital velocity and rotation compared to the Earth
 - C. it's actual distance from our Sun, measured in parsecs
 - D. the degree of shift that will account for its relative position in the night sky
13. A police officer might pull you over because you were speeding. The officer can prove you were traveling at a certain speed because the radar device that is used sends out a radio signal that reflects off your vehicle. The difference in wavelength is the speed you are traveling. This is a practical everyday application of this scientific principle - the ...
- A. parallax effect
 - B. spectrometer effect
 - C. ripple effect
 - D. doppler effect

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
		
Details	Details	Details

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 its 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.

4.1 Society and the Environment

1. There have been three disasters, emphasizing how dangerous space travel is for astronauts. The disaster that occurred shortly after lift-off was the ...
 - A. **Apollo 1**
 - B. **Apollo 13**
 - C. **Challenger**
 - D. **Columbia**
2. There are risks to sending astronauts to the moon as well. During a routine mission to the moon, Apollo 11 had to readjust their landing site, when the original site was found to be too rocky. Their precise fuel supply restricted them to
 - A. **try 1 more landing**
 - B. **try 2 additional landings**
 - C. **try 3 additional landings**
 - D. **scrub their mission and return to Earth.**
3. A hazard for satellites in space is the Sun. Without adequate protection from a surge of electrically charged particles (a 'coronal mass ejection' – also called 'solar flares') this could occur ...
 - A. **misdirection of signals**
 - B. **fried electrical circuits**
 - C. **orbital failure**
 - D. **system software glitches**
4. A 'coronal mass ejection' can also harm astronauts by killing cells in vital organs and damaging bone marrow. They are protected when they ...
 - A. **wear their space suits**
 - B. **wear metallic vests**
 - C. **use reflective vests**
 - D. **use polyethelene shielding**
5. One hazard to us on Earth is the re-entry of a satellite. Most of the satellite will burn up, but this type of debris can cause us great harm ...
 - A. **reflective**
 - B. **radioactive**
 - C. **reactive**
 - D. **re-entry**

4.2 Canadian Contributions to Space Exploration and Observation

6. Probably the most famous contribution to the space exploration program is the Canadarm. It was designed to be deployed and used on the shuttle missions and is a permanent part of the International Space Station. It made its debut in space on the shuttle Columbia in ...
 - A. **1977**
 - B. **1981**
 - C. **1995**
 - D. **2001**

7. There are three main systems of the Canadarm 2 used on the International Space Station. The part that travels along a rail system to move into different positions on the station is called ...
- A. **Monorail Repair Unit**
 - B. **Mobile Base System**
 - C. **Remote Manipulator System**
 - D. **Special Purpose Dexterous Manipulator**
8. Canada launched a satellite in 1972 making it the 1st nation to use a satellite for ...
- A. **GPS locator beacons**
 - B. **finding natural resources**
 - C. **broadcasting television signals**
 - D. **military use**
9. The 1st module to land on the moon was aided by this, which was built in Canada ...
- A. **landing gear**
 - B. **Canadarm L2**
 - C. **retro rockets**
 - D. **heat shield**
10. The 1st Canadian to go into space was ...
- A. **Sir Edward Sabine**
 - B. **Chris Hadfield**
 - C. **Robert Thirsk**
 - D. **Marc Garneau**

4.3 Issues Related to Space Exploration

11. Do you think there is oxygen on the Moon? Scientists believe they can produce it by heating this ...
- A. **carbon**
 - B. **carbon dioxide**
 - C. **volcanic rock**
 - D. **cosmic dust**
12. One of the benefits to spending all that money on space exploration is the potential for 'mining' natural resources. These natural resources hold the greatest promise on ...
- A. **Moon**
 - B. **Mars**
 - C. **Jupiter**
 - D. **Asteroid Belt**
13. Who owns space? In order to establish an answer to a question such as this, it must be discussed and reflected upon. This type of question is considered to be ...
- A. **a decision**
 - B. **an issue**
 - C. **rhetorical**
 - D. **a solution**

**Unit 5****Space Exploration**

Science In Action 9

Section 1.0 Understanding of Earth and Space has Changed over Time

- Ancient cultures – myths and legends
- Technology to study space has evolved through history
- Earth orbits a star (billions of stars in the Milky Way Galaxy)
- Accurate data & telescope technology improve understanding
- Star position – uses compass direction (azimuth) and altitude

Section 2.0 Technological Developments to Explore Space

- **Rocketry** has advanced over time
- Humans basic needs must be met in order to live in space
- Satellites provide information on weather, communications and global positioning as well as identify natural resources on the Earth
- Applied in communications, medicine, entertainment, transportation

Section 3.0 Telescopes and other Space Technologies

- **Reflecting** (mirrors) and **Refracting** (lenses) telescopes focus light
- **Electromagnetic Spectrum**: visible light, infrared, X-ray, ultraviolet, gamma radiation
- **Star spectrum shift** determines if it is moving away or towards us
- **Triangulation** and **Parallax** used to measure distance in space

Section 4.0 Space Exploration & Tech. affect Society & the Environment

- Dangers of space exploration: **debris, radiation**
- Canadian contributions – history of research and exploration
- Space Ownership issues: political, environmental and ethical

Section 1.0 Understanding of Earth and Space has Changed over Time

Key Concepts ❖ **Ancient cultures – myths and legends**

What **myths and legends** explained about space by **ancient cultures**? Fill in the table.

	The width of a mitt was used at arm’s length to gauge the height of the Sun above the horizon. When it was 1 mitt-width, seal pups would be born in two lunar cycles.
First Nations of the Pacific Northwest	
	The megaliths erected at Stonehenge were arranged in concentric circles to mark the summer and winter solstices.
Mayans	
	The pyramids were built to align with the seasonal positions of certain stars
Greeks	
	Key rocks in medicine circles aligned with the bright star that rose in the dawn, such as Aldebaran, Rigel, and Sirius.

Illustrate the two Models of Planetary Motion

Geocentric	Heliocentric
-------------------	---------------------

Astronomer who developed this model ...	Astronomer who developed this model ...

Kepler discovered what was missing from the heliocentric model. It was _____

Key Concepts ❖ Technology to study space has evolved through history

Identify the **astronomers tools** used to make observations of the sky.

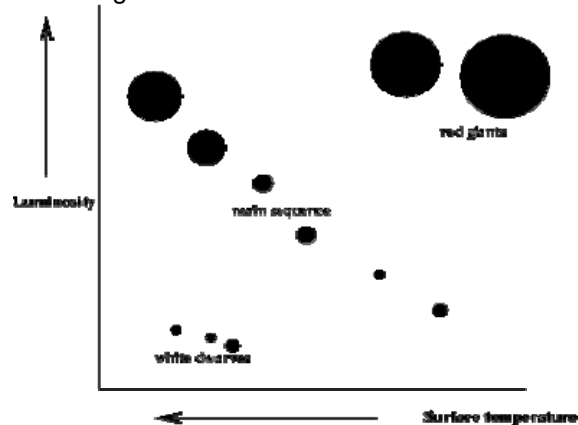


How did each improvement help to **advance our understanding** of what was observed?

Explain the difference between **Astronomical Units** and **Light-years**.

Key Concepts ❖ Earth orbits a star (billions of stars in the **Milky Way Galaxy**)

What does the **Hertzsprung-Russell** diagram show?

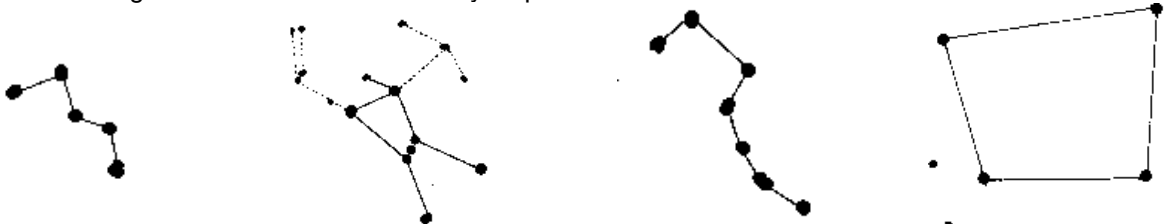


Illustrate the life cycles of **massive stars** and **Sun-like stars**.

What is a **Black Hole** and how is it formed?

Myths and legends are used to explain **constellations**, based on their unique patterns. Those that are included in myths and legends, but are not officially recognized as constellations are called **asterisms**.

Identify the following **constellation / asterism** by its pattern.



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What are the three types of galaxies?

Key Concepts ❖ Accurate data & telescope technology improve understanding

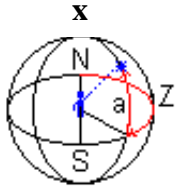
What are the three stages in the formation of a solar system? (The '**protoplanet hypothesis**')

1. _____
2. _____
3. _____

Review your planet spreadsheet information cards prepared in class.

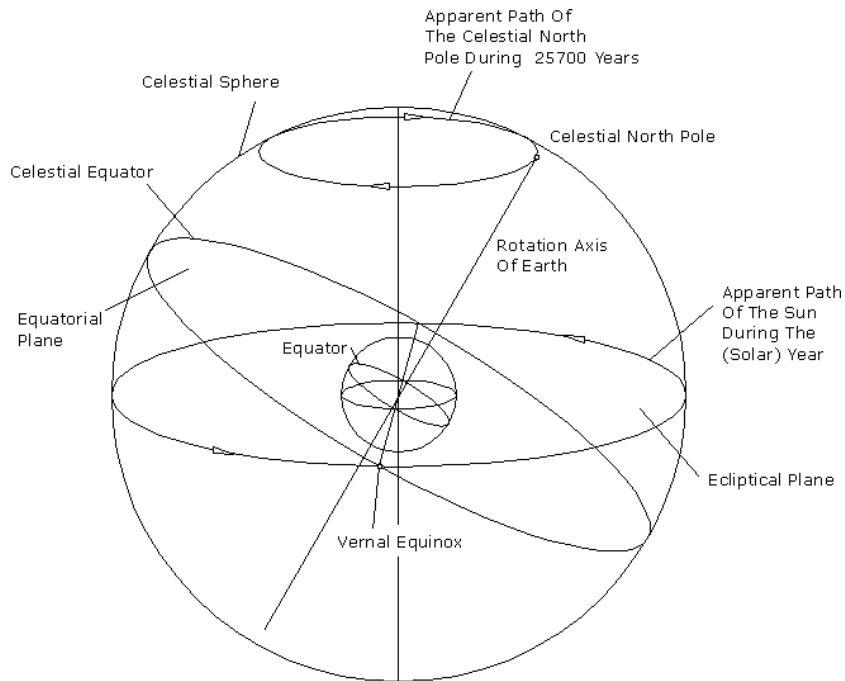
What is **SETI** ?

Key Concepts ❖ Star position – uses compass direction (**azimuth**) and altitude.



x	
a	
Z	

Explain what the **Celestial Sphere** is used for.



Section 2.0 Technological Developments to Explore Space

Key Concepts ❖ **Rocketry** has advanced over time

Identify the 3 main parts of a **rocket**.

Part	Function

Explain the difference between **ion drives** and **solar sails**.

Ion Drive	Solar Sails

Identify the three main types of **spacecraft** and what they are used for.

Type of spacecraft	What it is used for ...

Key Concepts ❖ **Humans basic needs must be met in order to live in space**

Give examples for each type of **Hazard of Living In Space**

HAZARD	Examples
Environmental Hazards	
Psychological Challenges to Confined Living	
Microgravity and the Human Body	

Briefly describe the purpose of a **space suit** and how has it been improved over the years.

What are the functions of the **Life Support Systems** on the **International Space Station**?

- _____
- _____
- _____
- _____
- _____

Key Concepts ❖ Satellites provide information on weather, communications and global positioning as well as identify natural resources on the Earth

What is the difference between ‘natural satellites’ and ‘artificial satellites’?

Explain how each type of satellite is used for a specific purpose.

Type of satellite	What it is used for ...
Communication	
Observation and Research	
Remote Sensing	
Personal Tracking	

Give a practical application, for use on the Earth, of a material that was originally developed for use in the space program, by each field identified in the table below.

Field	Space Use	Earth Use
Computer		
Consumer		
Medical		
Industry		
Transportation		
Public Safety		
Entertainment		

Section 3.0 Telescopes and other Space Technologies

Key Concepts ❖ **Reflecting** (mirrors) and **Refracting** (lenses) telescopes focus light

Illustrate two different optical telescopes used to study space

Reflecting (mirrors) telescopes	Refracting (lenses) telescopes

What is Interferometry?

Describe the advantages of the Hubble Space Telescope over Earth-based telescopes

Key Concepts ❖ **Electromagnetic Spectrum:** visible light, infrared, X-ray, ultraviolet, gamma radiation

How do scientists and astronomers use the many different forms of ‘invisible’ electromagnetic energy?

Energy Form	Space Use	Earth Use
Radio		
microwave		
infrared		
ultraviolet		
X-ray		
Gamma		

Describe how an **array** is useful to astronomers ...

What is the purpose behind sending space probes out into space?

Key Concepts ❖ **Triangulation** and **Parallax** used to measure distance in space

Using **triangulation**, determine the distance across a gorge. Show all your work.

Information you will need:

Baseline is 25 m

Angle a) is

Angle b) is

Scale 1 cm = 5m

What is **parallax**?

Key Concepts ❖ **Star spectrum shift** determines if it is moving away or towards us

How is a star's **composition** determined?

How is a star's **position** (coming toward or moving away) determined?

What is the **Doppler Effect** and what practical applications use it?

Section 4.0 Space Exploration & Technology Affect Society & the Environment

Key Concepts ❖ Dangers of space exploration: **debris, radiation**

Identify the tragedy and danger involved in space travel.

Danger	Year	Tragedy
Training exercise prior to launch		
	1986	
		Columbia Space Shuttle

Explain how space junk can be dangerous?

Key Concepts ❖ Canadian contributions – history of research and exploration

Complete the following table of Canadian Space Moments

Year	Canadian	Moment
1839		
1962		
1972		
1984		
	Roberta Bondar	
		1st Canadian to walk in space

Key Concepts ❖ Space Ownership issues: political, environmental and ethical

Identify the questions as political, environmental or ethical and pose a question in each of these categories:

Issue	Political	Environmental	Ethical
Who has the authority in space?			
Should we explore an alien home?			
What should be done with waste in space?			
	X		
		X	
			X

SPACE EXPLORATION MULTIPLE CHOICE UNIT TEST ITEMS

1.1 Early Views About The Cosmos

1. Many dates in the celestial calendar are marked by the amount of daylight. In the Northern Hemisphere the longest day occurs on June 21 and is called ...
 - A. Vernal equinox
 - B. Autumnal equinox
 - C. Summer solstice
 - D. Winter solstice
2. The width of a mitt was used by the **Inuit** peoples in the high Arctic to gauge the height of the Sun above the horizon. When it rose to one mitt-width high it meant ...
 - A. The days would get longer and warmer
 - B. The nights would get colder and shorter
 - C. Seal pups would be born in two lunar cycles
 - D. The Northern Lights would shine their brightest
3. Copernicus proposed a different model to explain planetary motion. His model, called the Heliocentric model. Galileo Galilei later confirmed his model, in his observations with one of the first telescope. But it was this Johannes Kepler, who put in place what was missing from Copernicus' model. He realized that the orbits of the planets were ...
 - A. circular
 - B. geocentric
 - C. intersecting
 - D. ellipses

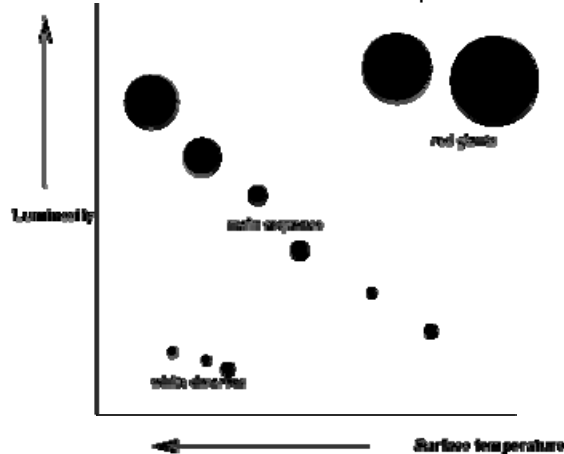
1.2 Discovery Through Technology

4. In the 2nd Century A.D. Egyptian astronomers used an instrument, called a **quadrant** to ...
 - A. measure the angle between the Moon and any given star
 - B. identify details in the far reaches of the night sky
 - C. chart astronomical position and predict the movement of stars
 - D. measure a star's height above the horizon
5. Arabian Astronomers used an instrument, called an **astrolabe** to ...
 - A. measure the angle between the Moon and any given star
 - B. identify details in the far reaches of the night sky
 - C. Make accurate charts of star positions predict the movement of stars
 - D. measure a star's height above the horizon
6. When measuring the diameter of the sun, we use an indirect method, so that we can determine the diameter without actually measuring it directly. To calculate the accuracy of your measured value, this is calculated to show how far from the real value your measured value is ...
 - A. actual error
 - B. estimated error
 - C. percent error
 - D. adjusted error

1.3 The Distribution Of Matter In Space

7. In the 1920's two scientists began comparing the surface temperature of stars with the star's luminosity. They graphed their results in what is referred to as the ...
- Solar Shift Model
 - Hertzsprung-Russell Diagram
 - Wegener-Darwin Illustration
 - Helio-Solar Diagram

Use this illustration to answer the question ...



8. What they discovered when plotting their data was that ...
- star temperature and brightness was not random
 - star temperature and size were related
 - star brightness and size were related
 - star size and shape were related to brightness
9. At the end of the life cycle of a star it explodes in a catastrophic event called a ...
- massive
 - supergiant
 - black hole
 - supernova

1.4 Our Solar Neighborhood

10. Constellations are groupings of stars that we see as patterns. The International Astronomical Union recognizes 88 officially. There are other patterns that are unofficially recognized, such as The Big Dipper, and are known as ...
- anomalies
 - asterisms
 - asteroids
 - aspergummies
11. Solar winds pass the Earth at an average speed of 400 km/s. This protects us from the devastating effects of the solar winds ...
- Earth's atmosphere
 - Earth's gravity
 - Earth's magnetic field
 - Earth's ozone

12. During a solar eclipse this is visible ...
- A. the sun's core
 - B. the sun's electromagnetic shield
 - C. the sun's atmosphere
 - D. the sun's corona

1.5 Describing The position of Objects In Space

13. The direction directly overhead is called ...
- A. azimuth
 - B. altitude
 - C. zenith
 - D. astroplane
14. To locate an object in the sky, two questions must be solved. How high is it in the sky? and in what direction is it? The term that identifies the **compass direction** is ...
- A. azimuth
 - B. altitude
 - C. zenith
 - D. astroplane
15. When constructing an astrolabe to locate the position of a star in the night sky, the **protractor** is used to determine the ...
- A. azimuth
 - B. altitude
 - C. zenith
 - D. astroplane

2.1 Getting There: Technologies for Space Transport

16. Getting a rocket into space was the first hurdle to overcome in order to be successful with space exploration. The speed that is needed is 28,000 km/h. This speed is referred to as the ...
- A. Maximum thrust
 - B. Speed of sound
 - C. Escape velocity
 - D. Speed of light
17. What did the Chinese of the 1st Century build to demonstrate their understanding and use of rockets?
- A. a 'pigeon'
 - B. a satellite
 - C. steam
 - D. arrows
18. Rocketry relies on a fundamental law of physics, ...
- A. Force is relative to distance
 - B. For every action there is an equal and opposite reaction
 - C. Gravity is a force that relates to rockets
 - D. Speed is equal to the force of gravity in the opposite direction

2.2 Surviving There: Technologies for Living In Space

19. The damaging effects of cosmic radiation is considered to be ...
- A. **An environmental hazard**
 - B. **A psychological challenge**
 - C. **A confinement problem**
 - D. **A microgravity threat**
20. There are several harmful effects to the body when living in microgravity for extended periods of time. Muscles ...
- A. **lose their color**
 - B. **expand**
 - C. **get brittle**
 - D. **shrink**
21. This is how oxygen is produced on the International Space Station.
- A. **Recycled water**
 - B. **Filtering CO₂**
 - C. **Heated air**
 - D. **Nitrogen control**

2.3 Using Space Technology to Meet Human Needs on Earth

22. **LANDSAT** and **RADARSAT** are Canadian satellites that monitor ships at sea, soil quality, track forest fires, report on environmental change & search for natural resources. These satellites are **NOT** in ...
- A. **Earth orbit**
 - B. **geosynchronous orbit**
 - C. **use 24 hours a day**
 - D. **alignment with radar stations on the Earth**
23. **GPS** satellites enable you to find out your exact position on the Earth at any time. 24 GPS satellites are orbiting the Earth at all times. To use the GPS system you need to get a signal from ...
- A. **2 of them**
 - B. **3 of them**
 - C. **4 of them**
 - D. **6 of them**
24. Space Age materials are used on the Earth as well as in space. The improvement of **traction** on car winter tires is the result of an application originally developed for ...
- A. **parachute material for the Viking space mission**
 - B. **voice-controlled wheelchairs**
 - C. **structural analysis of a spacecraft**
 - D. **microlasers for communication**

3.1 Using Technology To See the Visible

25. **Interferometry** is a technique of using telescopes in combination. The advantage of using two or more telescopes together is that astronomers are able to ...
- A. **work together**
 - B. **see more detail**
 - C. **hypothesize about images**
 - D. **create more colorful images**

- 26 One of the newest innovations for ground-based optical reflecting telescopes is the use of ...
- A. metal instead of glass
 - B. liquid instead of glass
 - C. segmented mirrors
 - D. mirror arrays
- 27 The **Hubble Space Telescope** offers a solution to the problems faced by astronomers on the Earth. Despite the remote mountain locations of ground-based telescopes to get away from light and air pollution, astronomers on the Earth still have to deal with interference caused by ...
- A. noise
 - B. aircraft
 - C. weather
 - D. earthquakes

3.2 Using Technology to See Beyond the Visible

- 28 Optical telescopes give us information based on visible light. However, objects in space, such as stars and galaxies, also emit many forms of electromagnetic energy. The energy form that has the longest wavelength is ...
- A. infrared
 - B. gamma
 - C. x-ray
 - D. radio
- 29 Although **neutral hydrogen** (which makes up a large bulk of matter in space) emits no light, it does emit energy at a specific wavelength. Astronomers are able to map out this neutral hydrogen in our Milky Way galaxy by using these type of telescopes ...
- A. radio telescopes
 - B. infrared telescopes
 - C. refracting telescopes
 - D. interferometry telescopes
30. **Radio Interferometry**, the combinations of many radio telescopes enables astronomers to improve performance and accuracy of images. They can more accurately measure position if they are ...
- A. at a higher altitude
 - B. closer to sea level
 - C. closer together
 - D. further apart

3.3 Using Technology to Interpret Space

31. If you have a baseline and know the angles to an object - an unknown distance away - you can accurately determine its actual distance away by using this method ...
- A. trigonometry
 - B. interferometry
 - C. triangulation
 - D. base ten math

32. **Parallax** is the *apparent shift in position of a nearby object when the object is viewed from two different positions*. Astronomers use a star's parallax to determine ...
- A. what angles to use when they triangulate the star's distance from Earth
 - B. it's orbital velocity and rotation compared to the Earth
 - C. it's actual distance from our Sun, measured in parsecs
 - D. the degree of shift that will account for its relative position in the night sky
33. A police officer might pull you over because you were speeding. The officer can prove you were traveling at a certain speed because the radar device that is used sends out a radio signal that reflects off your vehicle. The difference in wavelength is the speed you are traveling. This is a practical everyday application of this scientific principle - the ...
- A. parallax effect
 - B. spectrometer effect
 - C. ripple effect
 - D. doppler effect

4.1 The Risks and Dangers of Space Exploration

34. There are risks to sending astronauts to the moon. During a routine mission to the moon, Apollo 11 had to readjust their landing site, when the original site was found to be too rocky. Their precise fuel supply restricted them to
- A. try 1 more landing
 - B. try 2 additional landings
 - C. try 3 additional landings
 - D. scrub their mission and return to Earth.
35. A hazard for satellites in space is the Sun. Without adequate protection from a surge of electrically charged particles (a '*coronal mass ejection*' – also called '*solar flares*') this could occur ...
- A. misdirection of signals
 - B. fried electrical circuits
 - C. orbital failure
 - D. system software glitches

36. One hazard to us on Earth is the re-entry of a satellite. Most of the satellite will burn up, but this type of debris can cause us great harm ...
- A. reflective
 - B. radioactive
 - C. reactive
 - D. re-entry

4.2 Canadian Contributions to Space Exploration and Observation

37. There are three main systems of the *Canadarm 2* used on the *International Space Station*. The part that travels along a rail system to move into different positions on the station is called ...
- A. Monorail Repair Unit
 - B. Mobile Base System
 - C. Remote Manipulator System
 - D. Special Purpose Dexterous Manipulator
38. Canada launched a satellite in 1972 making it the 1st nation to use a satellite for ...
- A. GPS locator beacons
 - B. finding natural resources
 - C. broadcasting television signals
 - D. military use
38. The 1st Canadian to go into space was ...
- A. Sir Edward Sabine
 - B. Chris Hadfield
 - C. Robert Thirsk
 - D. Marc Garneau

4.3 Issues Related to Space Exploration

40. One of the benefits to spending all that money on space exploration is the potential for 'mining' natural resources. The place where these natural resources hold the greatest promise is on the ...
- A. Moon
 - B. Mars
 - C. Jupiter
 - D. Asteroid Belt
41. Although space exploration holds great promise and potential, there are political, ethical, economic and environmental issues associated with continued exploration endeavors. ***Do we have the right to spend money on space exploration rather than fixing our problems here on Earth?*** This issue would be classified as ...
- A. ethical
 - B. political
 - C. economic
 - D. environmental
42. ***Who owns space?*** In order to establish an answer to a question such as this, it must be discussed and reflected upon. This type of question is considered to be ...
- A. a decision
 - B. an issue
 - C. rhetorical
 - D. a solution



Unit E Space Exploration ANSWER KEYS



Section 1 Quiz

1	C	6	A	11	B	16	B	21	C
2	B	7	D	12	A	17	C	22	A
3	C	8	C	13	D	18	C	23	B
4	A	9	A	14	D	19	D	24	D
5	D	10	C	15	D	20	C	25	B

Section 2 Quiz

1	C	5	D	9	A	13	C
2	C	6	D	10	A	14	B
3	C	7	C	11	B	15	A
4	A	8	D	12	B		

Section 3 Quiz

1	B	5	C	9	D	13	D
2	A	6	D	10	B		
3	C	7	C	11	C		
4	B	8	A	12	A		

Section 4 Quiz

1	C	5	B	9	A	13	B
2	A	6	B	10	D		
3	B	7	B	11	C		
4	D	8	C	12	D		

Unit Test

1	C	12	D	23	B	34	A
2	C	13	C	24	A	35	B
3	D	14	A	25	B	36	B
4	D	15	B	26	C	37	B
5	C	16	C	27	C	38	C
6	C	17	D	28	D	39	D
7	B	18	B	29	A	40	D
8	A	19	A	30	D	41	A
9	D	20	D	31	C	42	B
10	B	21	A	32	A	NR 1	1432
11	C	22	B	33	D	NR 2	4312