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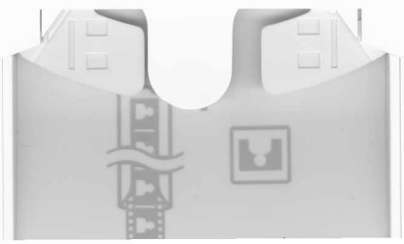
Unit E
Space Exploration

Key Concepts

- ☐ technologies for space exploration and observation
- ☐ reference frames for describing position and motion in space
- ☐ satellites and orbits
- ☐ distribution of matter through space
- ☐ composition and characteristics of bodies in space
- ☐ life-support technologies
- ☐ communication technologies

- ☐ identify different perspectives on the nature of Earth and space, based on culture and science *(e.g., describe cosmologies based on an Earth-centred univers, describe aboriginal views of space and those of other cultures)*
- ☐ investigate and illustrate the contributions of technological advances—including **optical telescopes, spectral analysis** and **space travel**—to a scientific understanding of space
- ☐ describe, in general terms, the distribution of matter in space *(e.g., stars, star systems, galaxies, nebulae)*
- ☐ identify evidence for, and describe characteristics of, bodies that make up the solar system; and compare their characteristics with those of Earth
- ☐ describe and apply techniques for determining the position and motion of objects in space,
- ☐ describing techniques used to estimate distances of objects in space and to determine their motion
- ☐ describing the position of objects in space, using angular coordinates *(e.g., describe the location of a spot on a wall, by identifying its angle of elevation and its bearing or **azimuth;** describe the location of the Sun and other stars using **altitude-azimuth coordinates**, also referred to as **horizon coordinates or local coordinates***
- ☐ Identify problems in developing technologies for space exploration, describe technologies developed for life in space, and explain the scientific principles involved
- ☐ describe technologies for life-support systems, and interpret the scientific principles on which they are based *(e.g., investigate systems that involve the recycling of water and air)*
- ☐ describe technologies for space transport, and interpret the scientific principles involved *(e.g.,describe the development of **multistage rockets, shuttles and space stations;***
- ☐ identify materials and processes developed to meet needs in space, and identify related applications *(e.g., medicines, remote sensing, microelectronics, polymers, medical imaging, **wireless** communication technologies, synthesis of fuels)*
- ☐ describe the development of artificial satellites, and explain the major purposes for which they are used *(e.g., **communication, GPS—global positioning system, weather observation)***
- ☐ Describe and interpret the science of **optical** and **radio telescopes, space probes** and **remote sensing technologies**
- ☐ Identify issues and opportunities arising from the application of space technology, identify alternatives involved, and analyze implications
- ☐ recognize risks and dangers associated with space exploration *(e.g., **space junk, fuel expenditure, satellites burning up in the atmosphere, solar radiation)***
- ☐ describe **Canadian** contributions to space research and development and to the astronaut program *(e.g., Canadarm)*



1. Using the information in the table below, indicate the order in which the events happened by placing a number beside each. The number 1 indicates the first event:

Event	Chronological Order
A. The construction of Stonehenge.	1
B. Galileo uses a telescope to study bodies in the solar system.	
C. Kepler suggests planets orbit the Sun in elliptical paths.	
D. Mayans build an observatory at Chichen Itza.	
E. Aristotle proposed an Earth-centred model of the solar system.	

_____ _____ _____ _____

B C D E

2. The aboriginal people of southwestern Alberta set up circles of rocks which aligned with prominent stars that were visible at the time of construction. These monuments to the heavenly bodies were believed to have special powers and were referred to as _____ _____.

3. Both of the early models of the solar system could reasonably explain the motion of the planets through space. How did these theories explain the fact that the stars in the background did not appear to move?

_____

_____

4. According to the distances in the table, how many times further is Neptune's orbit from Mars's orbit?

_____

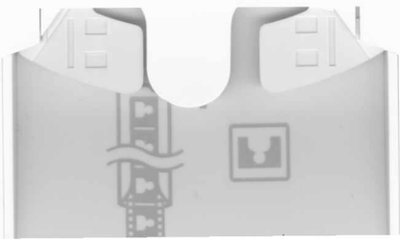
Planet	Distance from Sun in AUs
Mercury	0.4
Venus	0.75
Earth	1
Mars	1.5
Jupiter	5
Saturn	9.5
Uranus	19
Neptune	30
Pluto	39.5

5. Light travels at 300 000 km/s, and Venus is 112 500 000 km away from the Sun. How many minutes does it take light from the Sun to reach Venus? _____

6. Place the following in order of their invention from the earliest (number 1) to the most recent (number 4).

quadrant ___ telescope ___ merkhet ___ cross-staff ___

7. When measuring distances within our solar system, the unit most likely used is the _____ _____.



8. If you made a sundial by placing a golf tee upside down in the middle of circular graph paper and noted the position of the tee's shadow throughout the day, why did the golf tee's shadow change position as well as change length?

_____

_____

9. For each situation described below, identify whether it would occur early in a star's life, or later in a star's life. If it is an example of the **early stages of a star's life**, mark down a **1**. If it is an example of the **later stage of a star's life**, mark down a **2**.

___ A star collapses on itself and slowly begins to shrink.
___ A star begins to fuse hydrogen into helium releasing great amounts of heat.
___ A star erupts in a catastrophic explosion called a nova.
___ A star begins the stable portion of its life.

10. If you watched a constellation for several hours one night, it would appear to move in a(n) _____ to _____ direction.

11. _____ stars and _____ stars are formed in a nebula.

12. According to the Hertzsprung-Russell diagram, supergiant and giant stars are _____ and _____ than white dwarf stars.

13. How do astronomers know black holes exist if they do not emit any light?

_____

_____

14. Match each planet listed below with its planetary features.

Feature	**Planet**
A. very hot, heavily cratered, no atmosphere	1. Mars
B. orbits the Sun on its side	2. Venus
C. surface is extremely hot due to thick atmosphere	3. Mercury
D. small, rocky, has two tiny moons	4. Uranus

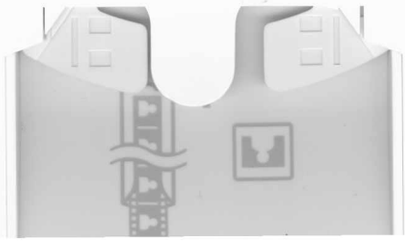
A. ___ C. ___
B. ___ D. ___

15. Our solar system is divided into two groups of planets: **inner** and **outer**. The dividing line for these two groups is the asteroid belt. Besides their position in the solar system, there are many characteristics that place these planets into the different groups. Place a 1 beside the description if it describes an inner planet, and place a 2 beside the description matching an outer planet.

___ rocky surface, short period of revolution
___ rocky core, covered in thick atmosphere of gas
___ many moons, ring systems
___ highest average surface temperatures

16. The effects of the _____ _____ push a comet's tail so that it always points away from the Sun.

17. _____ and _____ are the only two planets that do not have a moon.



18. The **protoplanet** hypothesis is used to explain the birth of a solar system. Describe the steps in the hypothesis.

_____

_____

19. **Altitude** and **azimuth** are measurements that give us the location of an object in space. In the following list, you will determine whether the given number represents an altitude measurement, an azimuth measurement, or neither. If the reading is an altitude measurement, place a 1 beside it. If the reading is an azimuth measurement, place a 2 beside it. If it is neither, place a 0 beside it.

Reading	**Altitude, azimuth or neither**
44°	___
N 23° E	___
N 361°	___
192°	___

20. The following examples describe everyday measurements. You will determine if the given measurement most resembles an **altitude** measurement, or an **azimuth** measurement. If the example resembles altitude, place a 1 beside it. If the example most resembles an azimuth measurement, place a 2 beside it.

___ the height of a horse
___ the direction to the next closest town to you
___ the size of a piece of pie you would like to cut
___ the distance a basketball hoop is from the ground

21. Explain why stars appear to maintain the same positions year after year.

_____

_____

22. When we identify the location of an object in space relative to our position on the ground, we give two measurements: azimuth and altitude. Why would it be difficult to locate a celestial body using only one measurement?

_____

_____

23. List the following space events in the order in which they occurred. Write a 1 beside the first event, and a 4 beside the last event.

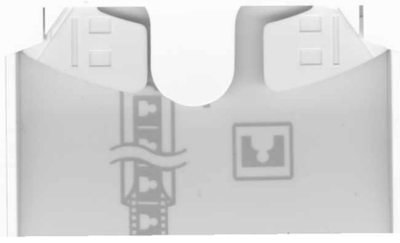
___ The United States launches the first space shuttle.
___ The Soviet Union launches *Sputnik*.
___ Canada launches its first satellite, *Alouette I*.
___ The first phase of the International Space Station is completed.

24. Consider four facts related to new devices used in propelling spacecraft.

1. uses sunlight
2. produces a weak thrust
3. is made of carbon fibre
4. requires one-tenth of the amount of fuel used by a chemically fuelled spacecraft

Place the number 3 if the statement is related to an ion drive engine and 4 if it is related to a solar sail.

Fact 1	Fact 2	Fact 3	Fact 4
_____	_____	_____	_____



25. In a solar sail, the Sun's electromagnetic energy, in the form of _____, is transferred to the sail, causing the spacecraft to move.

26. Rockets release gas under pressure to produce the thrust that makes them move. The gas in a chamber is released, causing the rocket to be pushed in the opposite direction. This is an example of the law of physics, "For every action, there is an equal and opposite _____."

27. The nature of a satellite's orbit depends on its specific use. For each of the following situations, place a 1 beside the satellite description if it is best suited for a stationary (geosynchronous) orbit, and a 2 if it is suited for orbiting around Earth.

___ a satellite providing digital television channels to northern Alberta
___ a satellite that spies on another country's military
___ a satellite giving weather reports for Southern Alberta
___ a satellite designed to compare heat patterns of the oceans

28. For each of the following, match the space-designed material or process with the Earth-bound "spin-off."

Space Use	**Earth Use**
A computer technology to conduct structural analysis of spacecraft	1. development of improved safety helmets and golf balls
B design of space food for astronauts	2. construction of voice-controlled wheelchairs
C study of aerodynamic and insulation materials	3. testing safety of buildings, bridges, etc.
D design of micro-circuitry for electronics of spacecraft	4. manufacture of enriched baby and freeze-dried foods

_____ _____ _____ _____
A B C D

29. Explain what **remote sensing** is.

_____

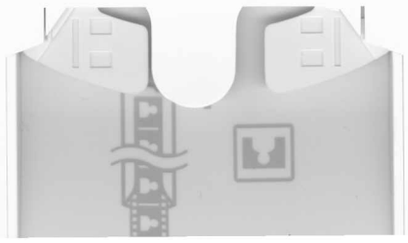
_____

30. Describe a situation where a person may not be able to locate their position using a GPS.

_____

31. Both **reflecting** and **refracting** telescopes have different ways of focusing light, but share some common components. The list below shows the main components of telescopes. Write a 1 beside the component if it is used in a refracting telescope. Write a 2 beside a component if it is used in a reflecting telescope. If the component is common to both telescopes, write a 0.

___ secondary mirror
___ primary light-gathering lens
___ primary light-gathering mirror
___ eyepiece lens

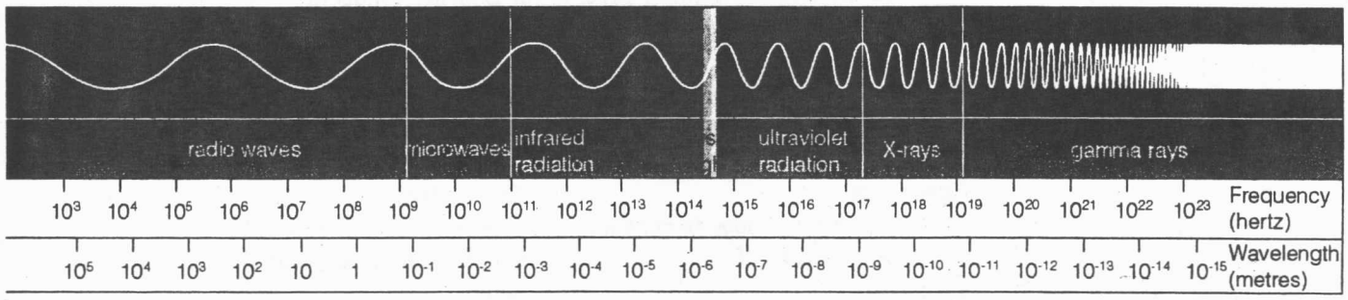


32. Place the following events in the order in which they occurred. Mark the first event to occur with a 1, and the others with a 2, 3, or 4.

The Hubble Space Telescope is launched. ___
Galileo uses his refracting telescope to see Jupiter. ___
The reflecting telescope of Keck I in Hawaii is completed. ___
Hans Lippershey makes a simple refracting telescope. ___

33. Label the following on the electromagnetic spectrum below.

(a) microwaves
(b) infrared radiation
(c) Xrays
(d) ultraviolet radiation
(e) radio waves
(f) gamma ray



34. Match the space probe with its mission.

Probe	Mission
A. Venera	1. flyby of Jupiter
B. Voyager	2. Mars landing
C. Galileo	3. Venus landing
D. Pathfinder	4. flyby of outer planets

A. ___
B. ___
C. ___
D. ___

35. Place each of the following examples of forms of electromagnetic energy in order from smallest wavelength (1) to largest wavelength (4).

radio waves ___ visible light ___ X-rays ___ microwaves ___

36. Large bursts of intense, high-frequency energy appear and then fade in space. The energy in these bursts is called _____ rays.

37. How is it possible for astronomers to simulate telescopes with lens diameters that are tens of thousands of kilometres wide?

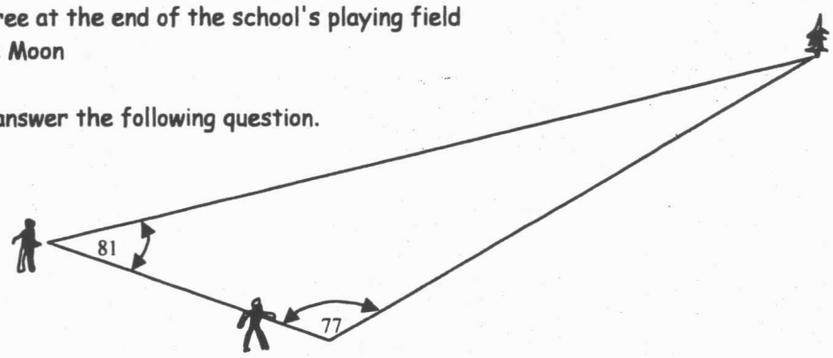
_____

_____

38. Both **triangulation** and **parallax** are methods of determining distances indirectly. For each of the following examples, suggest the most practical method of measurement. Write a 1 beside the example if you would use parallax. Write a 2 beside the example if you would use triangulation.

___ height of the school flagpole
___ distance from Earth to the nearest star, Beta Proxima
___ distance to a tree at the end of the school's playing field
___ distance to the Moon

Use the diagram below to answer the following question.



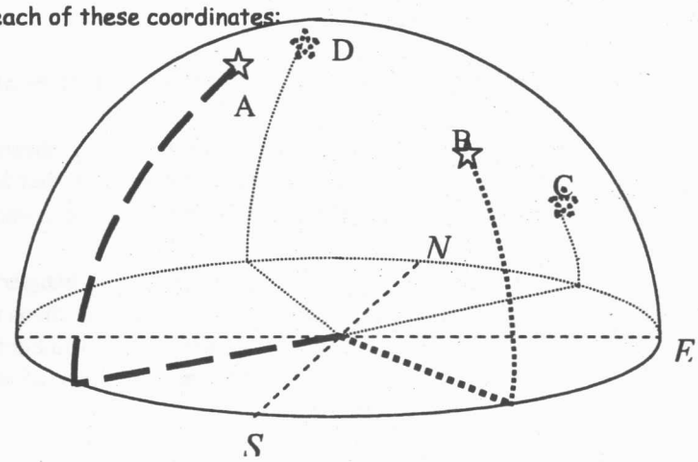
39. If the baseline for this measurement is 22 m, then how far away is the tree?

_____

_____

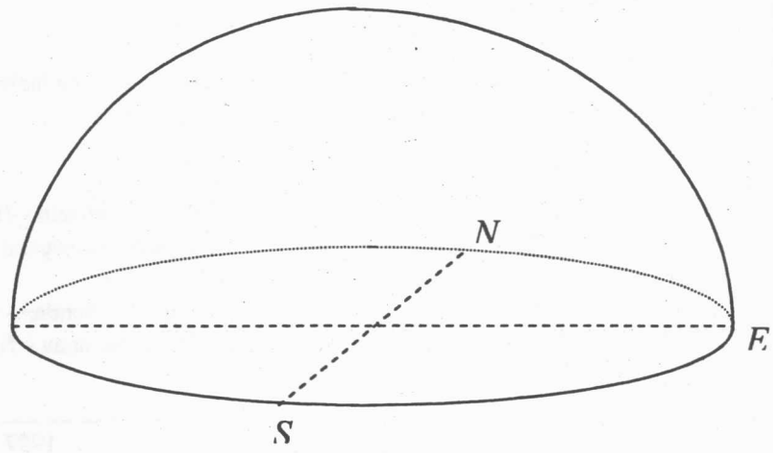
40. Use the following diagram to identify the star with each of these coordinates:

Star	Altitude	Azimuth
	80°	330°
	45°	135°
	70°	245°
	25°	50°



41. Place stars at the following (approximate) co-ordinates on the following picture:

Star	Altitude	Azimuth
P	50°	180°
Q	10°	260°
R	70°	30°
S	45°	110°



A star's colour is related to its surface temperature. The chart below shows spectral classifications, approximate temperatures, and colours for a variety of stars. (The temperatures are given in kelvins (K). The kelvin temperature scale starts at -273°C; thus 0 K equals -273°C. Use this table to answer questions 47 - 49.

Spectral Classifications

Spectral Class	Surface Temperature (K)	Colour
B	21 000	blue-white
A	10 000	white
F	7500	yellow-white
G	6000	yellow
K	4700	orange
M	3300	red

42. Place the following stars in order from hottest (1) to coolest (4).

Star	Colour	Ranking
Altair	white	___
Anteres	red	___
the Sun	yellow	___
Rigel	blue-white	___

43. Beta Pegasi is a giant star with a surface temperature of approximately 2000 K. The colour of this star is most likely _____.

44. The North Star, Polaris, has a surface temperature of about 7200 K. Polaris belongs to spectral class _____.

45. The history of space exploration contains many instances of disasters, or near disasters. The list below shows some examples of accidents and near accidents that have occurred in the last four decades of space travel. Label the events (1 to 4) in the order in which they occurred.

___ The space shuttle ***Challenger*** explodes shortly after takeoff.
___ ***Apollo 11*** lands on the Moon with seven seconds worth of fuel left.
___ A Soviet satellite fell to Earth, scattering radioactive debris.
___ The three-member crew of ***Apollo 1*** died during a fire on the launch pad.

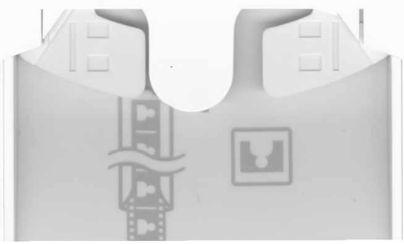
46. List the following space equipment in the order in which they were first used, starting with 1 as the oldest, and 4 as the newest.

___ Canadarm
___ space shuttle
___ Canadarm 2
___ International Space Station

47. Match the following milestones in Canadian space history with the correct year in which they occurred. Place the number of the event beside the correct year.

Date	Event
1984	1. **Chris Hadfield** - first Canadian to walk in space
1992	2. Canadian designed ramp used for Mars Pathfinder mission
1997	3. **Roberta Bondar** - first Canadian female astronaut in space
2001	4. **Marc Garneau** - first Canadian in space

_____ _____ _____ _____
1984 1992 1997 2001



48. The Mobile Base System of Canadarm 2 can move around by means of a _____ system.

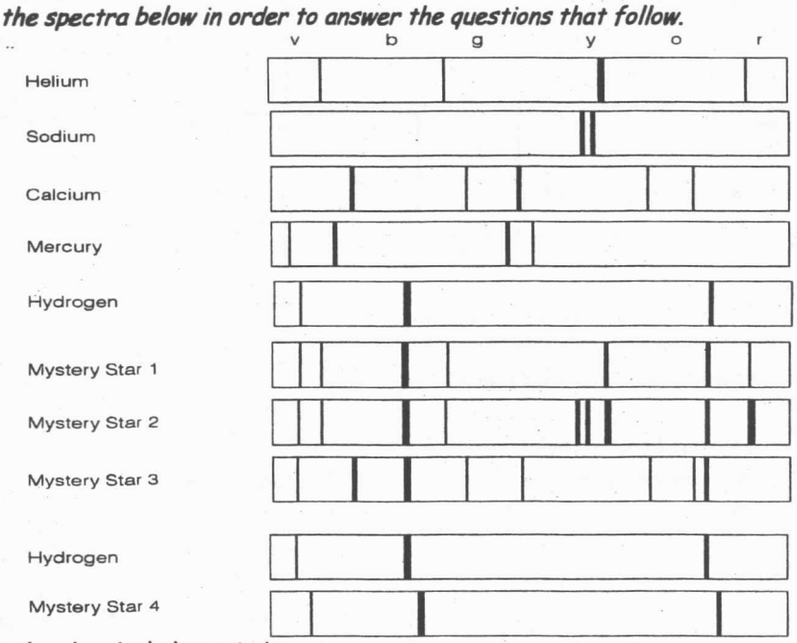
49. In any discussion about space exploration and exploitation, a number of issues need to be addressed. In the following list, classify each issue as political or environmental. Write a 1 beside the political issues and a 2 beside the environmental issues.

___ ownership of space resources (mineral, power, etc.)
___ maintaining an environment in space the way it was discovered
___ deciding which nations or groups will use space
___ assessing the necessity of cleaning up space junk

50. The amount of shift in a star's spectrum is determined by the _____ and _____ it is travelling.

51. When triangulation calculations are made, the longer the baseline, the more accurate the results. What is the longest baseline possible for measurements made from Earth? (A diagram may be useful for your explanation.)

Analyze the spectra below in order to answer the questions that follow.



52. List the chemical elements in:

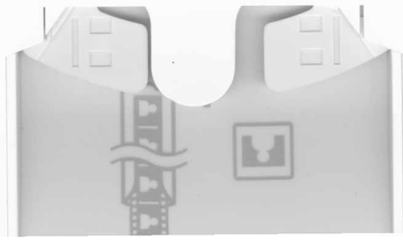
(a) Mystery Star 1 _____

(b) Mystery Star 2 _____

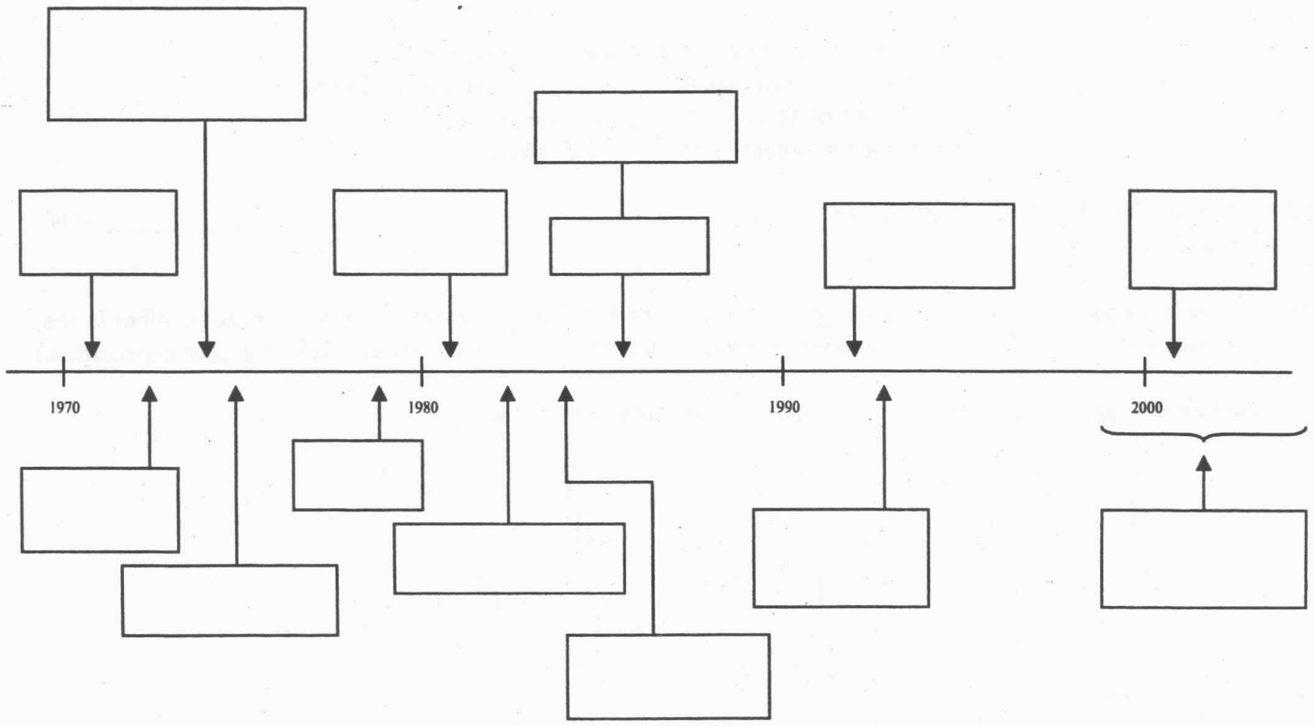
(c) Mystery Star 3 _____

53. Match each definition in column A with the correct term in column B. Draw a line from each definition to the corresponding term.

A	B
2. energy waves which include visible light	diffraction grating
3. apparent change of wave frequency caused by motion	interferometry
4. a device used to produce a spectrum	electromagnetic radiation
5. spectrum of a hot solid	continuous
6. technique that combines images from two telescopes	Doppler effect



Co-operation in Space



54. Place the following events in the correct space on the timeline.

(a) Canada launches *Anik 1* and is the first country to transmit television signals by satellite

(b) *Salyut 1* is the first space station

(c) Space shuttle program begins

(d) *Challenger*, explodes killing crew

(e) *International Space Station* is assembled in modular pieces

(f) Marc Garneau is the first Canadian in space

(g) *Mir* is launched

(h) *Mir* is brought down in big fireball

(i) *Skylab* falls to Earth

(j) *Apollo-Soyuz* U.S. and Soviet link-up

(k) *Skylab* is America's first space station

(l) *Challenger* explodes, killing crew

(m) Roberta Bondar is Canada's first woman in space

(n) First repair mission of the Hubble telescope

(o) CSA formed and Canada hires its first astronauts