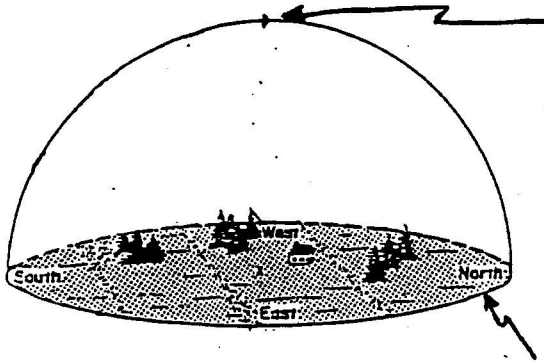
Astronomy

I. Celestial Observations

A. Celestial Object = Any object in Space (outside Earth's atmosphere

Examples : moon, planets, stars, Sun

B. Celestial Sphere = model of the sky

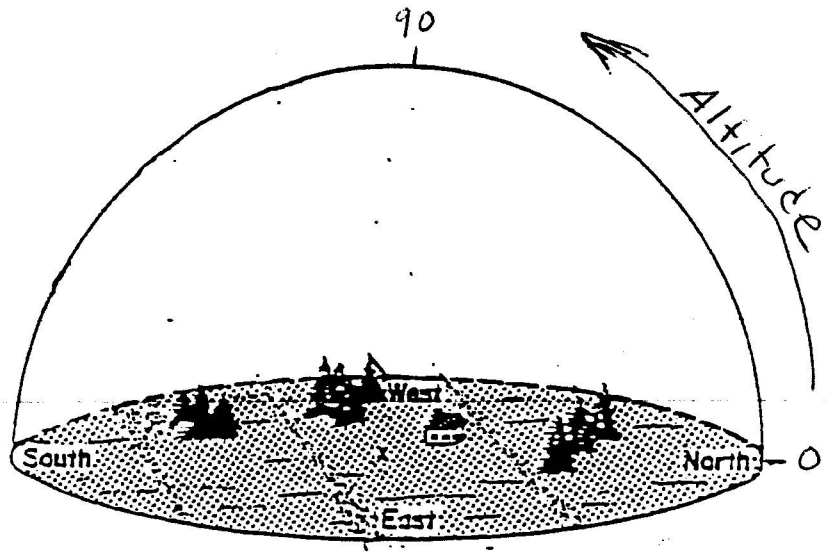


1. Zenith - highest point in the sky directly above the observer's head.

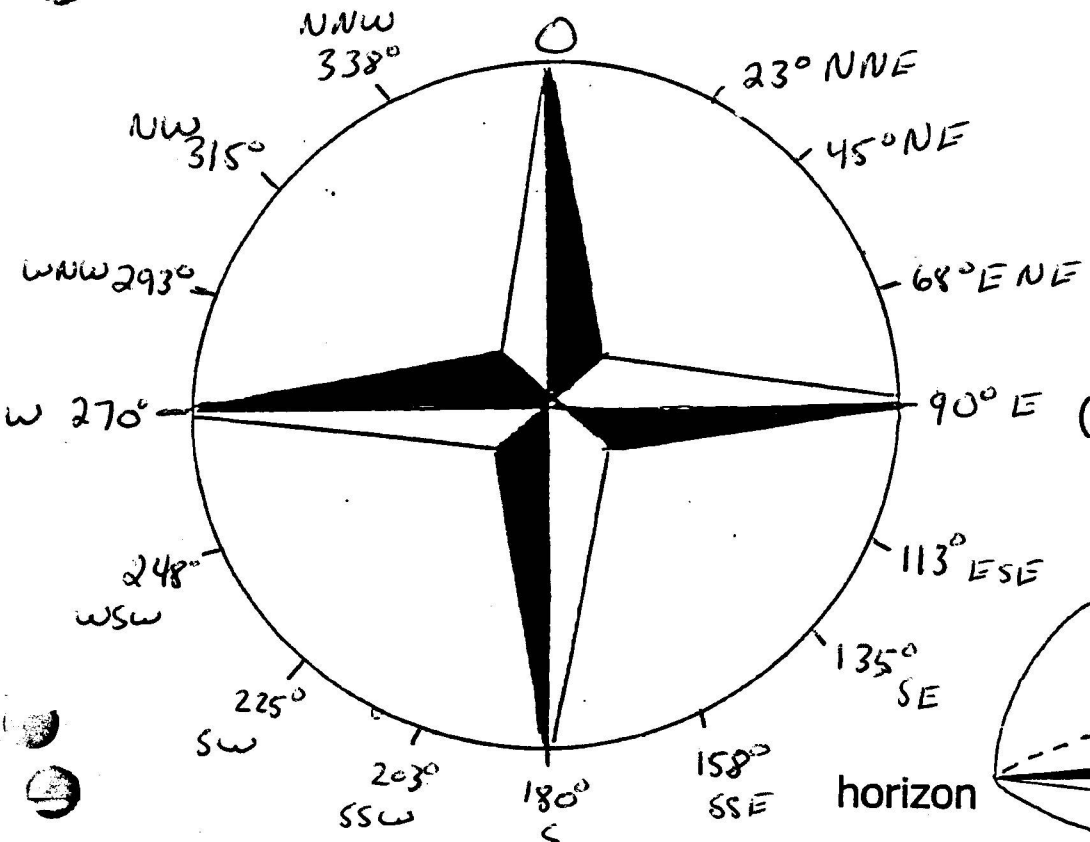
2. horizon - imaginary boundary between the sky and the ground

C. Location on the Celestial Sphere – THE HORIZON SYSTEM

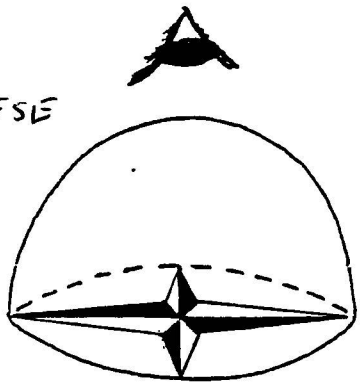
1. Altitude = angular distance above the horizon



1. Azimuth = angular distance along the horizon from North 0° clockwise



Top View
(looking down)

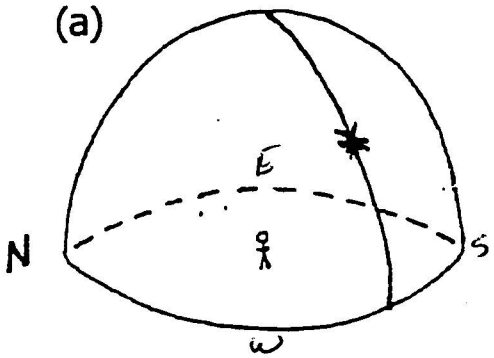


horizon

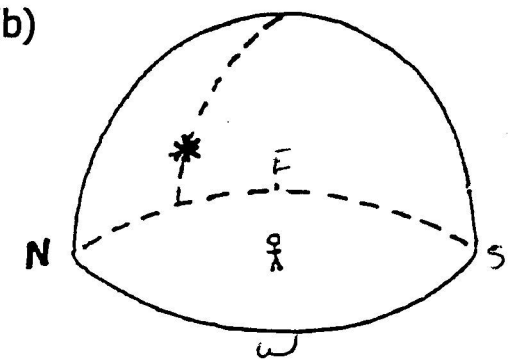
3. Model Problems – Azimuth and Altitude on the Celestial Sphere

By careful estimation, determine the azimuth –(Az) and the altitude (h) for the star (*) illustrated in each celestial sphere diagram.

(a)

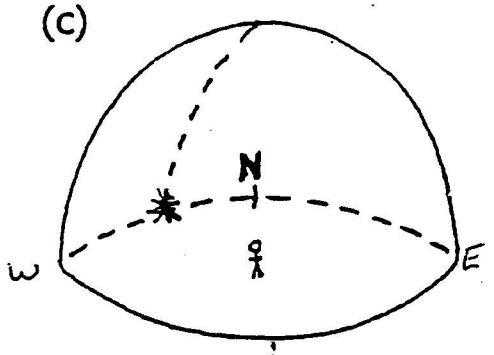


(b)

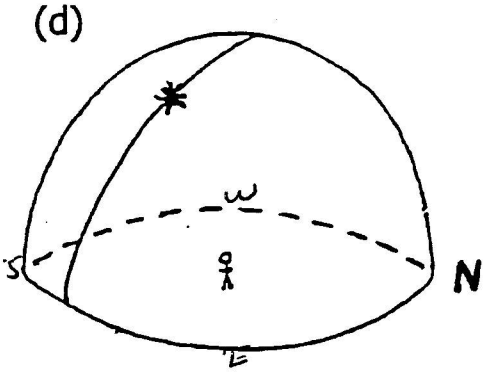


	Az	h	Az	h
Common Terms	SW	1/2	NE	1/3
Degrees	225°	45°	45°	30°

(c)



(d)



	Az	h	Az	h
Common Terms	NW	horizon	SSE	23
Degrees	315°	0°	157°	60°

II. Gravity

A. Newton's Laws of Gravity

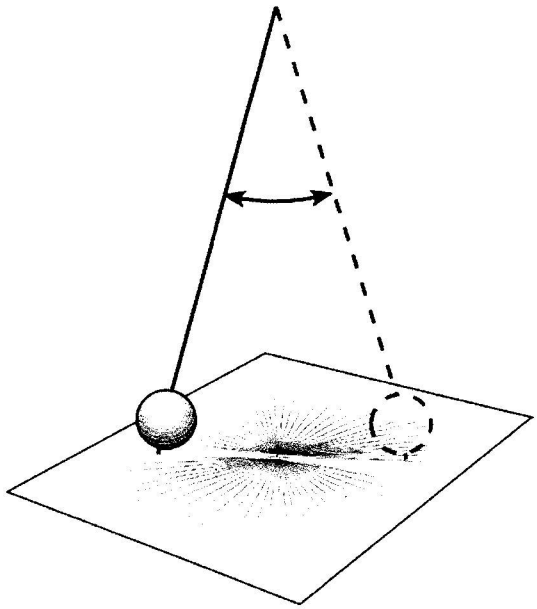
1. All objects possess gravity

and will pull all other objects with a certain gravitational force.

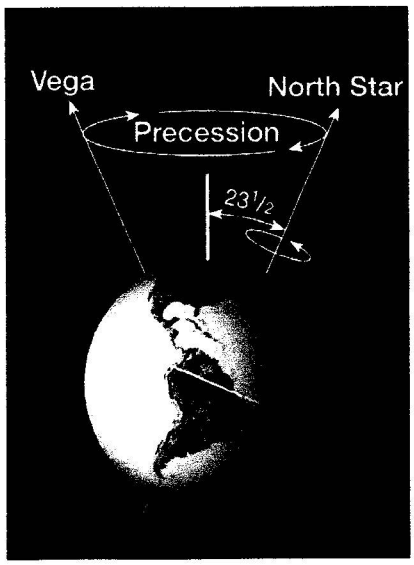
2. The mass of an object determines the amount of gravitational force that object possesses. The greater the mass, the greater the gravitational force.

3. The gravitational force between two objects changes as the distance between them change. As distance increases, gravity decreases.

A Foucault Pendulum proves the earth rotates.



Precession - A slow motion of earth's axis.



B. Gravity and Inertia

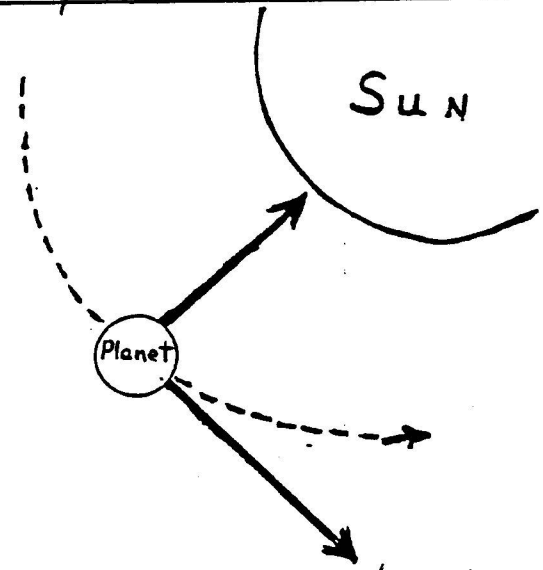
1. Newton's Law of Inertia states that an objects motion will not change unless that object is acted on by an outside force

2.

Inertia

Gravity

Stable orbit



a. Inertia - causes a planet to move in a straight line.

b. Gravity - pulls a planet towards the Sun.

III. Rotation - the spinning of a celestial body (Earth) on an imaginary axis

A. Earth's

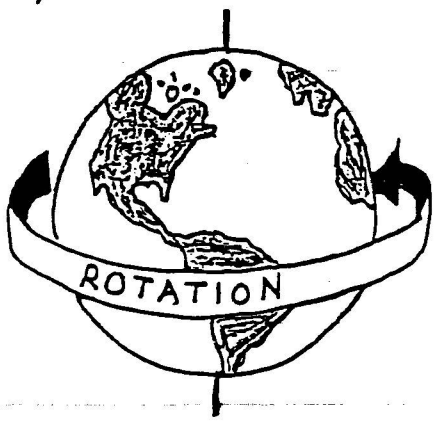
1. Direction of Rotation:

west to east

2. Angular Rate of Rotation:
THINK – one complete rotation

a. 360° degrees

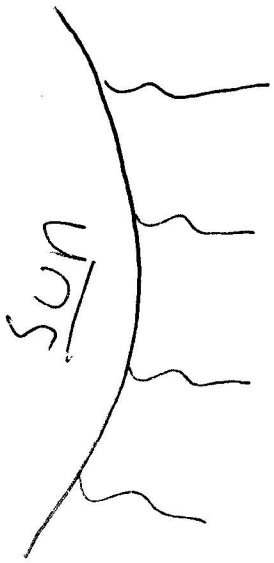
b. 24 hours

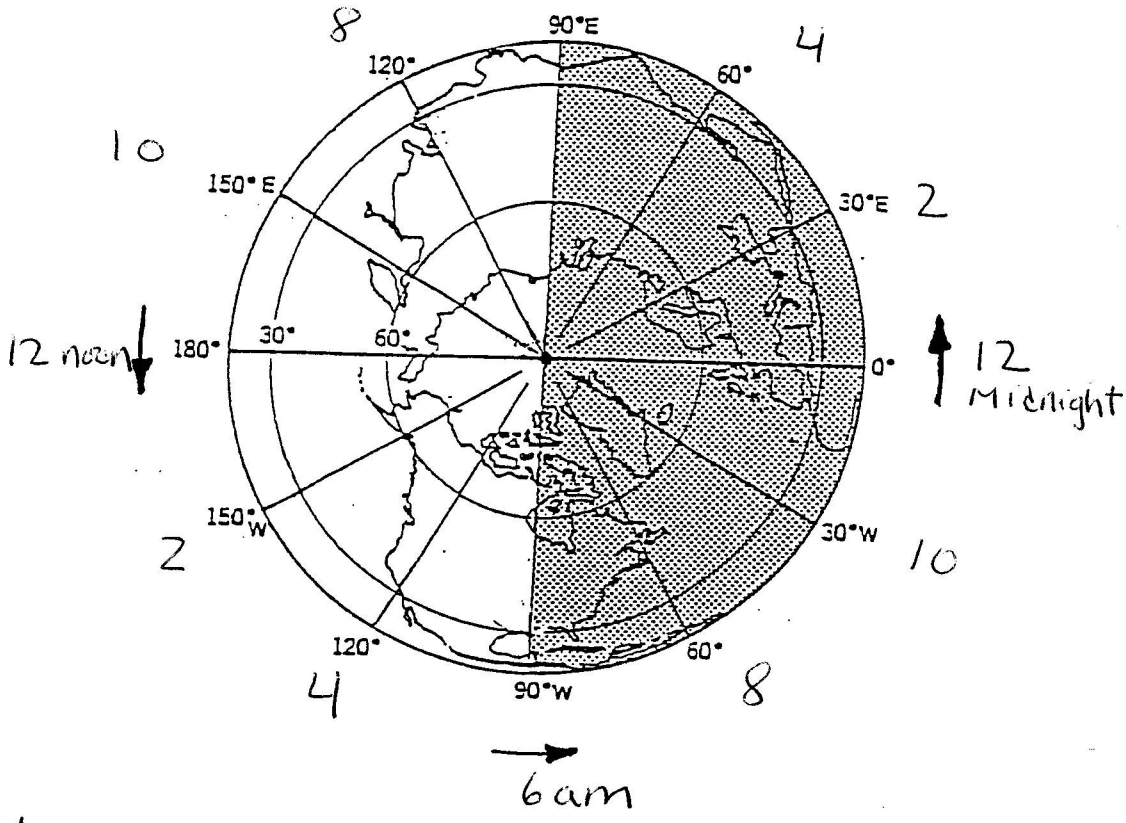


RATE = $\frac{360°}{24 hrs}$ 15°/hr.

B. Effects of Earth's Rotation

1. Day and Night

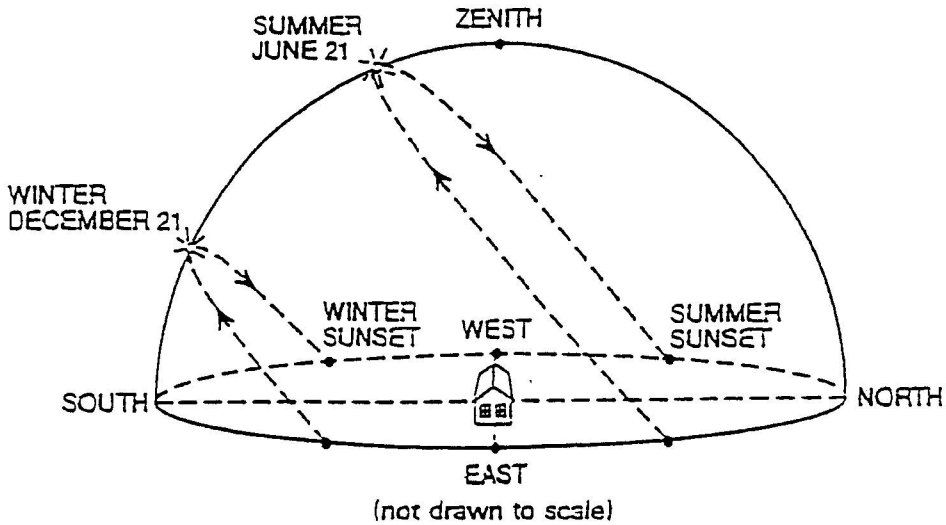




2. Apparent motion of Sun

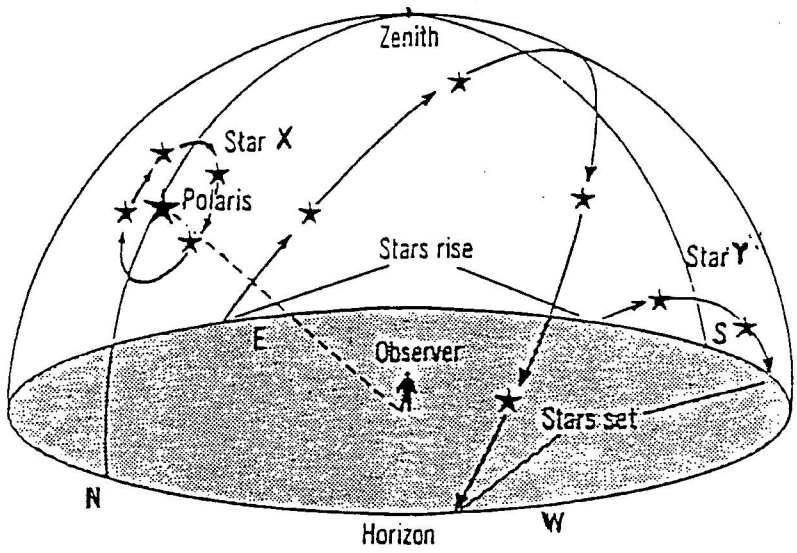
a. Earth rotates from west to east
(note diagram above)

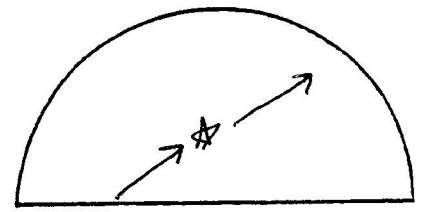
b. Sun "appears" to move in an arc from east to west (note diagram below)



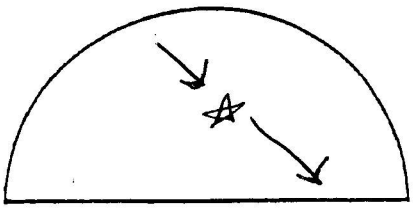
(not drawn to scale)

3. Apparent daily motion of the Stars

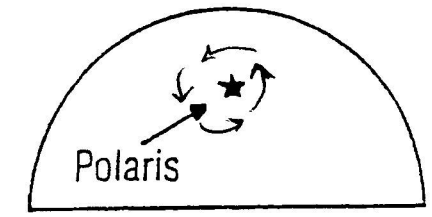




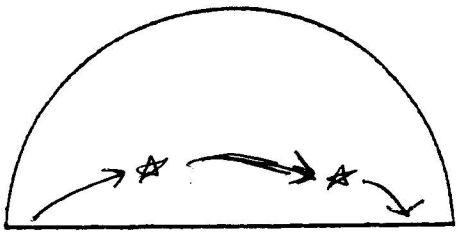
LOOKING EAST



LOOKING WEST

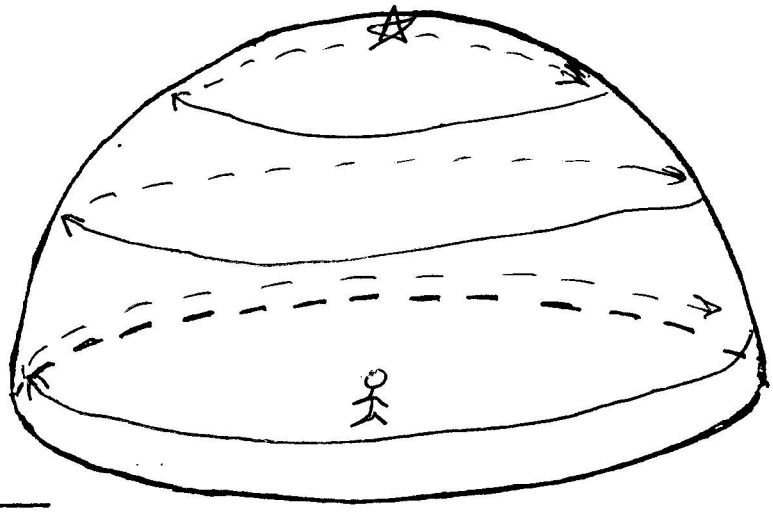


LOOKING NORTH



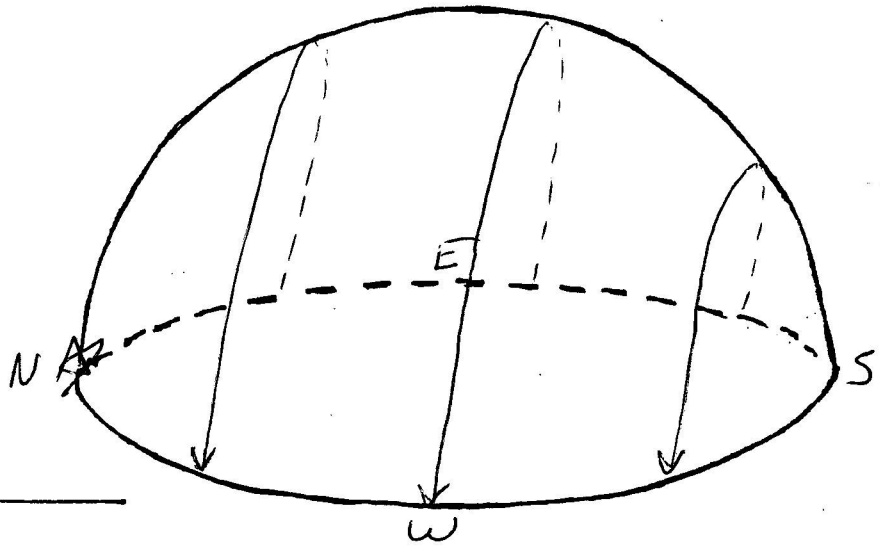
LOOKING SOUTH

b. The apparent daily motion of celestial objects (like stars) changes when the observer's latitude on Earth changes.



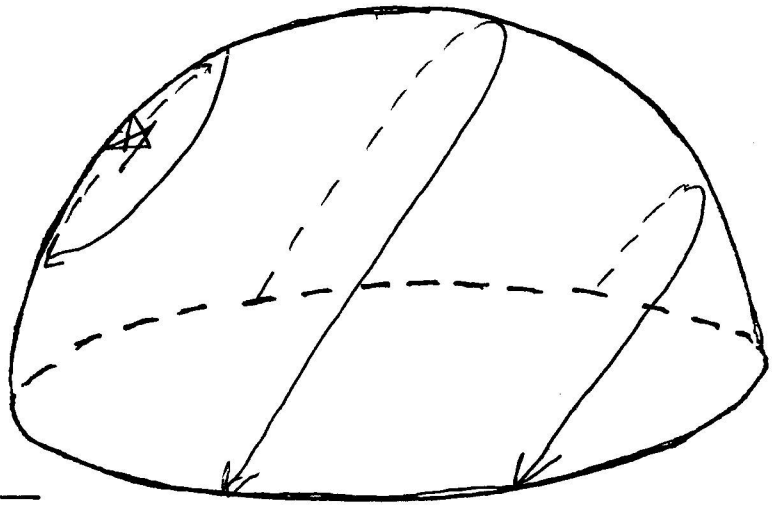
No stars rise or set

90°N



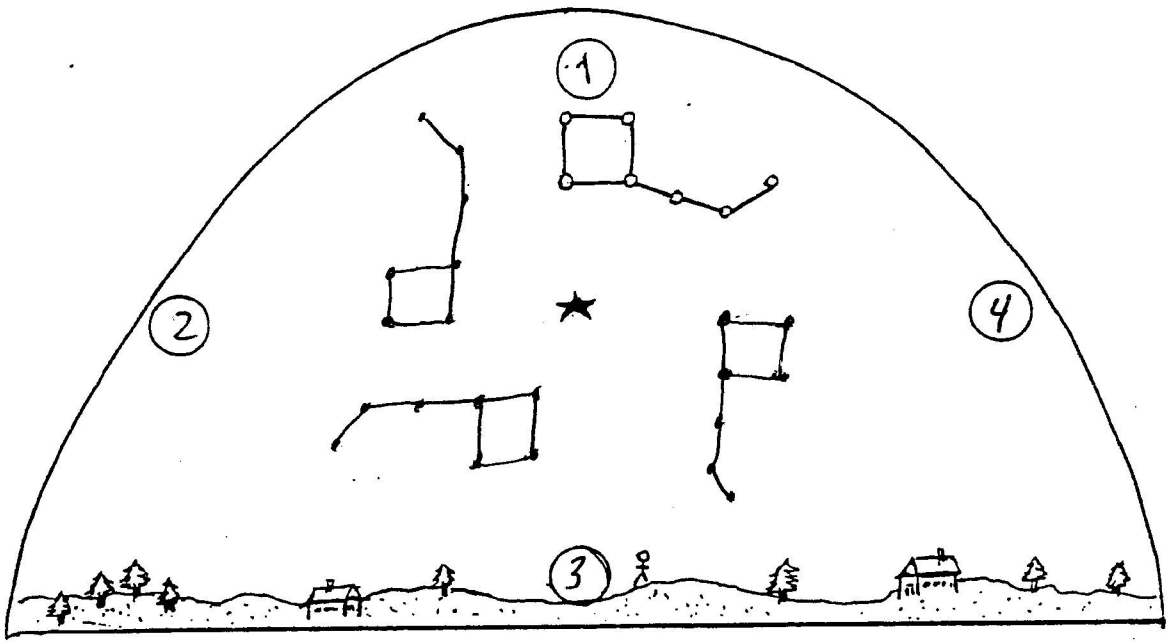
All stars rise or set

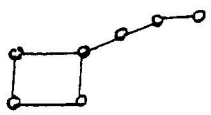
0° Equator



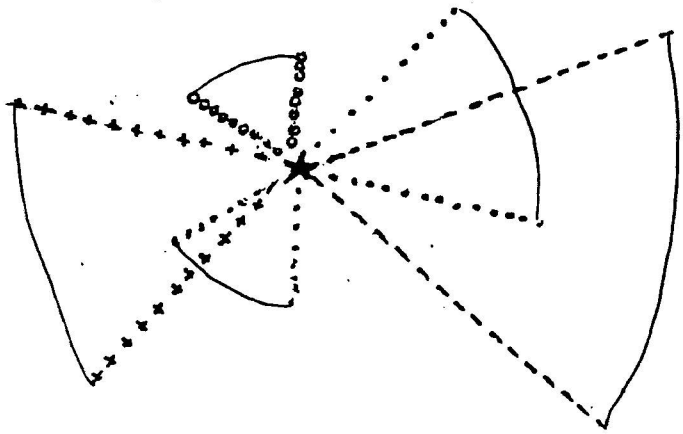
43°N (N.Y.S.)

c. The apparent daily motion of the Big Dipper, a ___circumpolar___ constellation.



LOCATION OF OBSERVER	N.Y.S.	
DATE	mid Oct	
POSITION OF THE BIG DIPPER 	9:00 pm	1
	3:00 am	2
	9:00 am	3
	3:00 pm	4

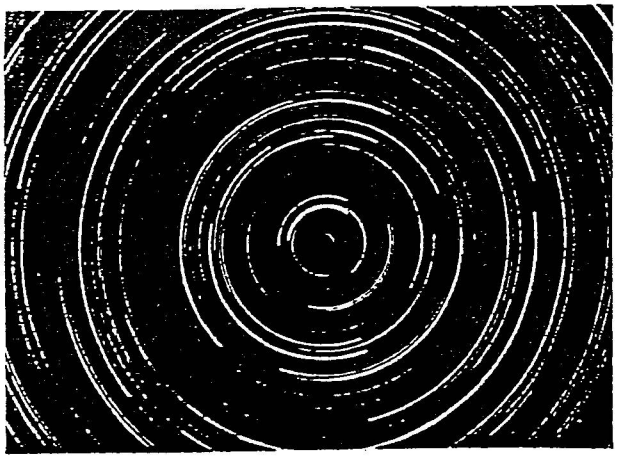
d. ___star trials___ - a time-exposed photographic image that shows the apparent motion of stars; it appears as a blurry line across the film.



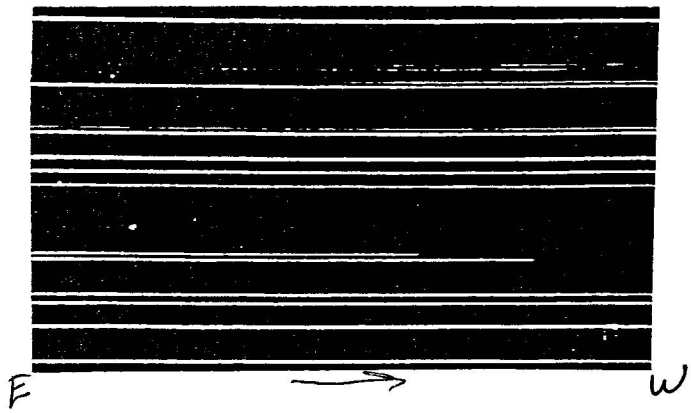
Time exposure
4 hours

Angular distance of star trails
60°

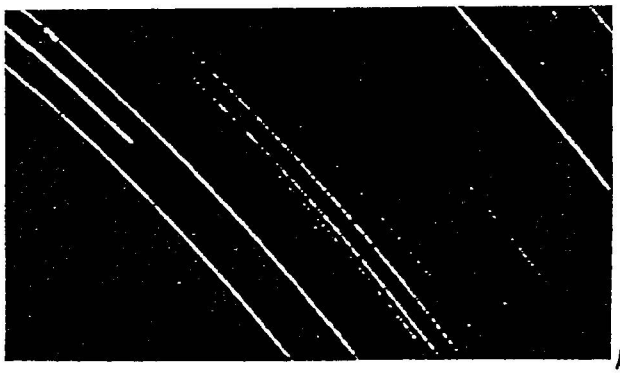
Star trail photographs looking north, south, east and west.



A. North



B. South

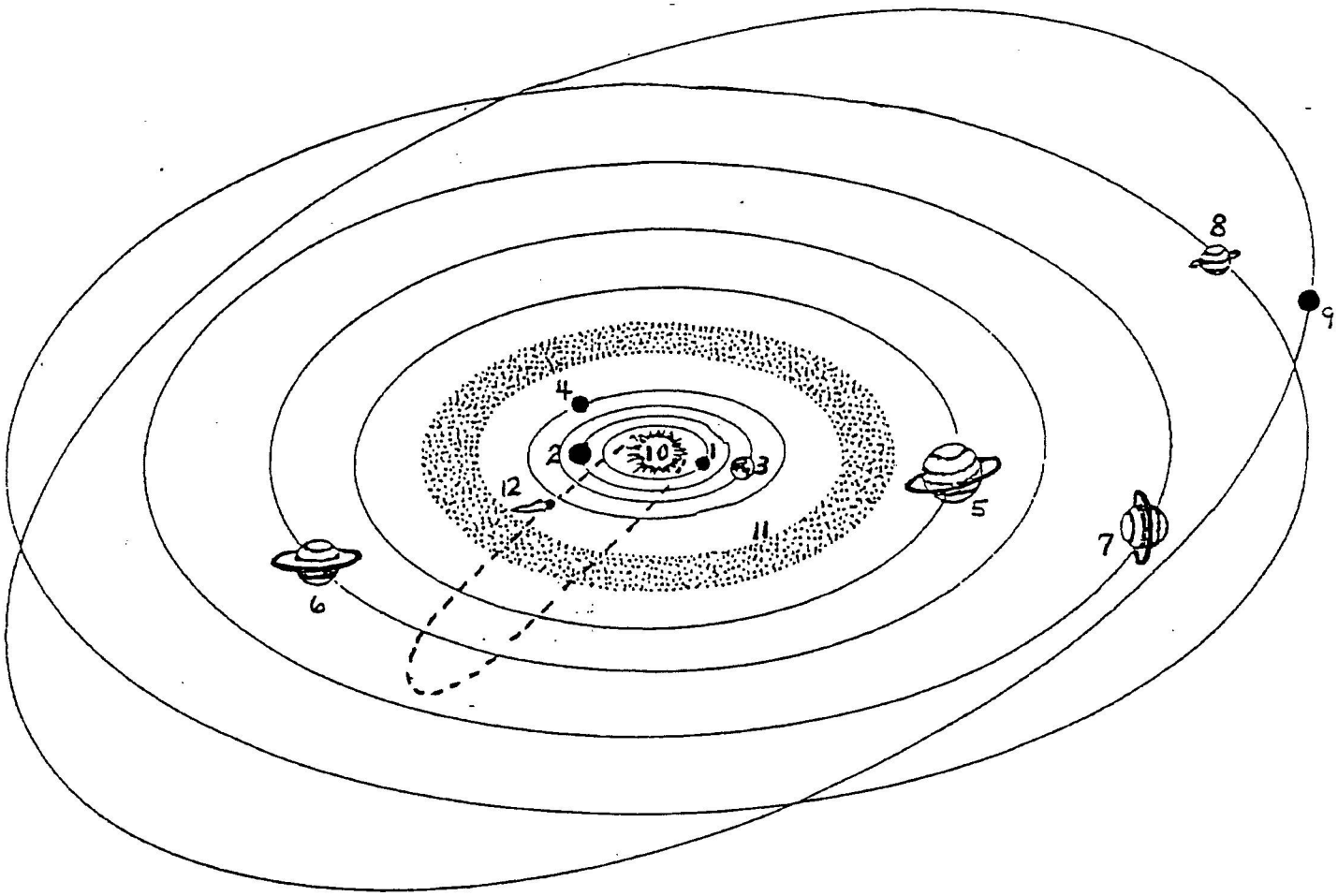


C. west

D. East

IV. The Solar System - The sun and all celestial bodies held by the sun's gravity and orbit the sun

A. Main components/members of the solar system:



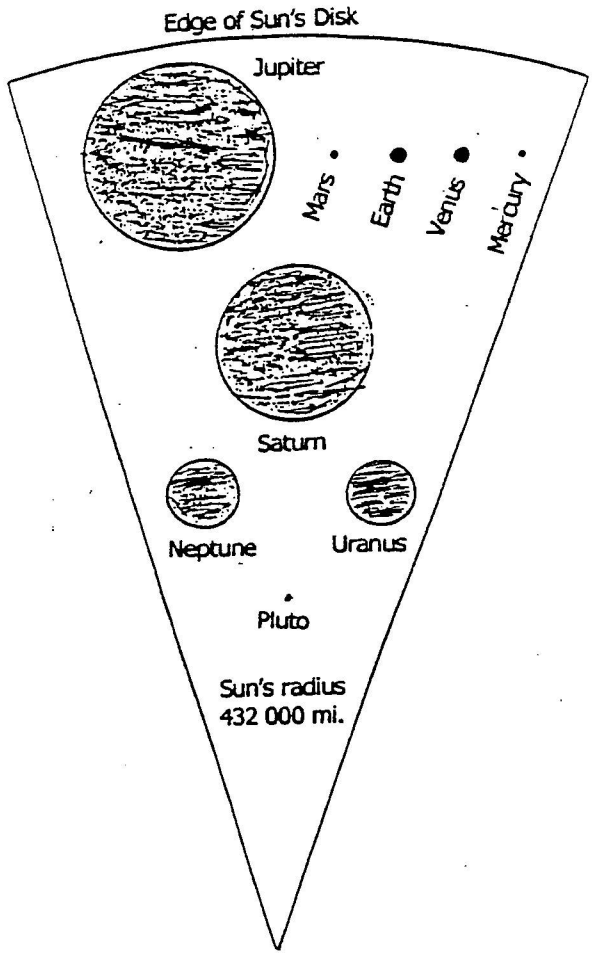
	NAME OF PLANET	SYMBOL
1	Mercury	☿
2	Venus	♀
3	Earth	⊕
4	Mars	♂
5	Jupiter	♃
6	Saturn	♄
7	Uranus	♅
8	Neptune	♆
9	Pluto	♇
10	Sun	
11	Asteroids	
12	Comet	

Terrestial Inner "earth Like planets"

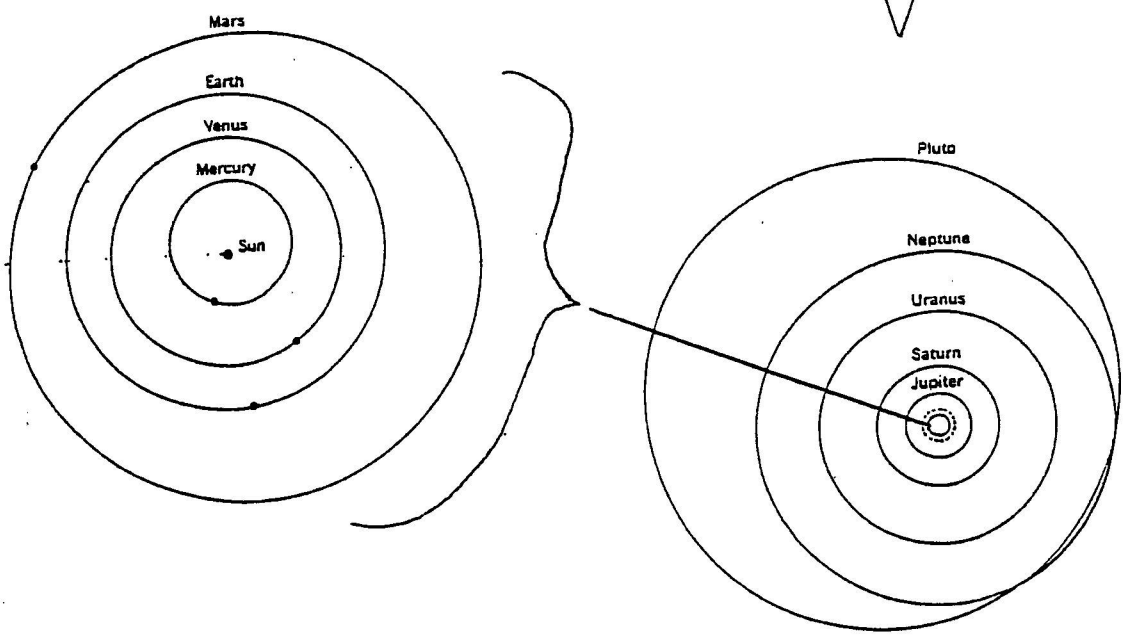
Gas Giants Jovian

B. The Planets

1. Relative size of the Sun and the planets



2. Orbits of the planets and their relative distances.



Orbits of the four planets nearest the sun.
The black dots represent perihelion points (closest point to the sun in their orbit.)

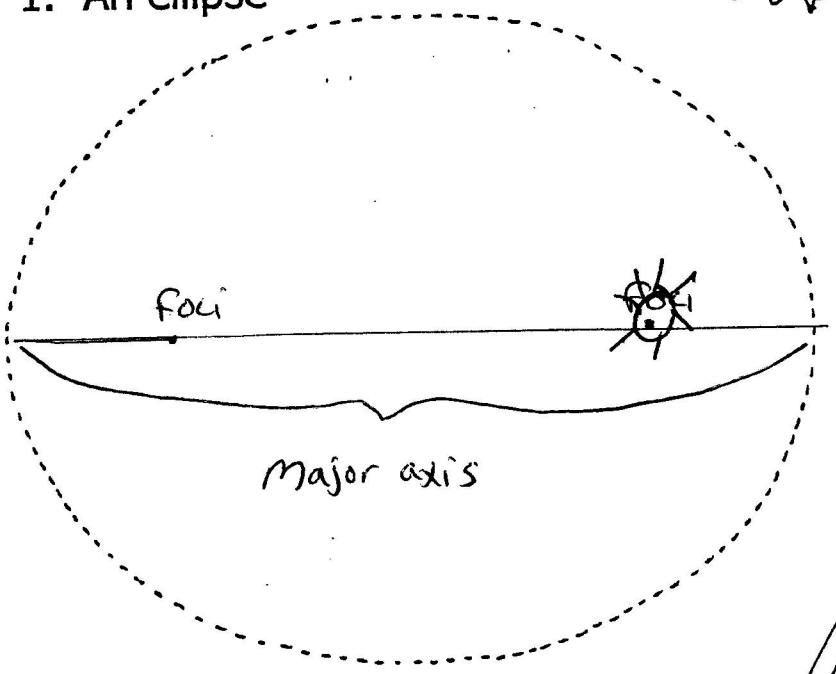
Orbits of the outer planets. The innermost circle represents Mars' orbit.
The dashed circle represents the zone of the asteroid belt.

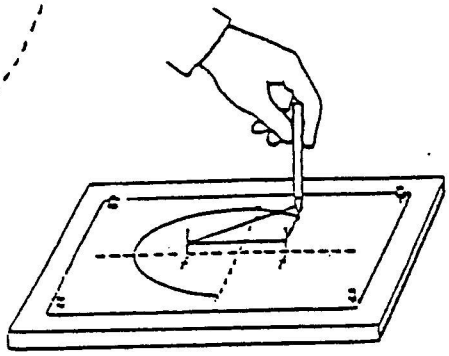
V. Kepler's laws of planetary motion

A. Law 1

The orbit of each planet is an ellipse, and the sun is at one foci.

1. An ellipse





2. Eccentricity – a measurement of the "shape" of an ellipse.

Reference Table page 1

a. Formula:

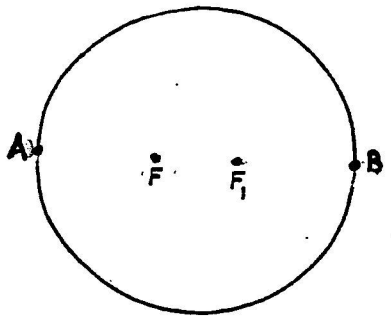
$$\text{Eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

b. Sample Problem – based on the ellipse above.

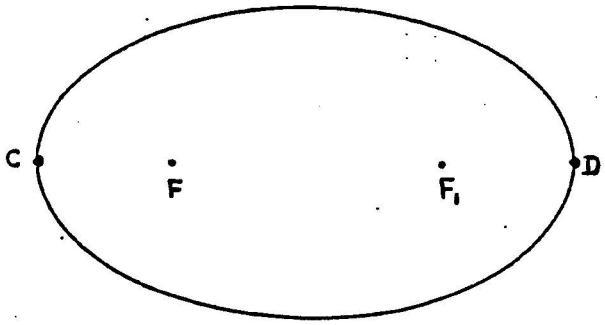
$$E = \frac{6.2\text{ cm}}{10.5\text{ cm}} = .5905$$

c. Eccentricity – Problems (range of values)

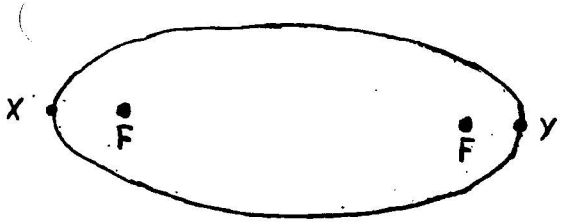
$E = \frac{D}{L}$



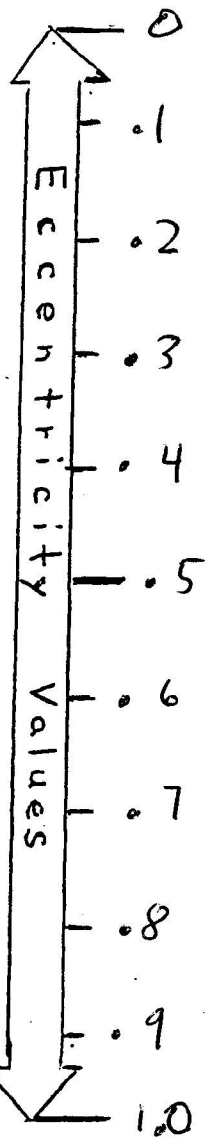
$E = \frac{1\text{ cm}}{4\text{ cm}} = E = .250$



$E = \frac{3.5\text{ cm}}{7.0\text{ cm}} = .500$

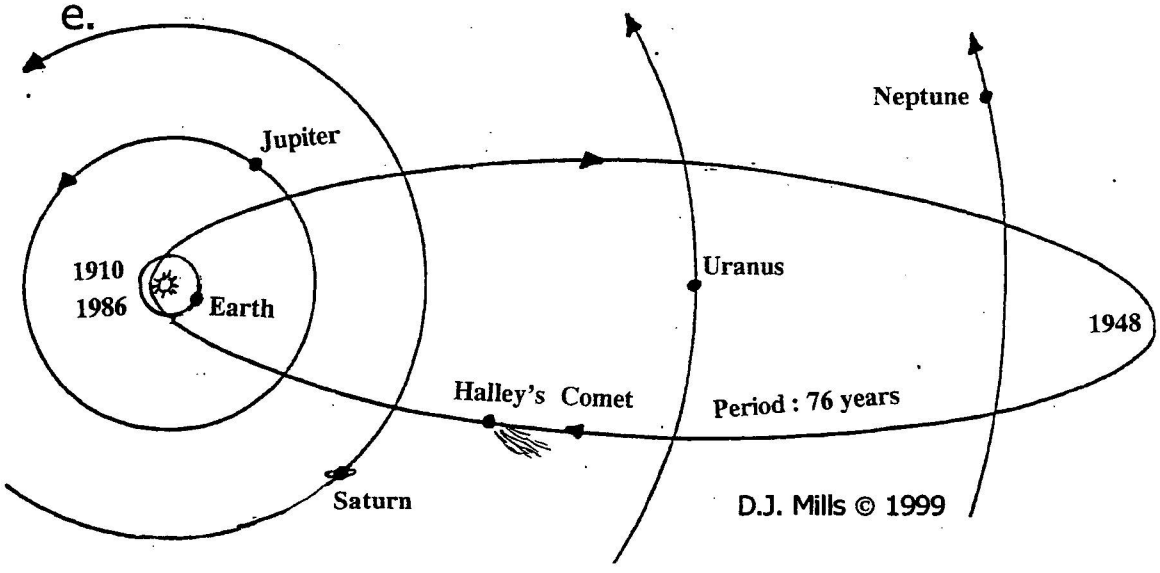


$E = \frac{4.5\text{ cm}}{6.0\text{ cm}} = .750$

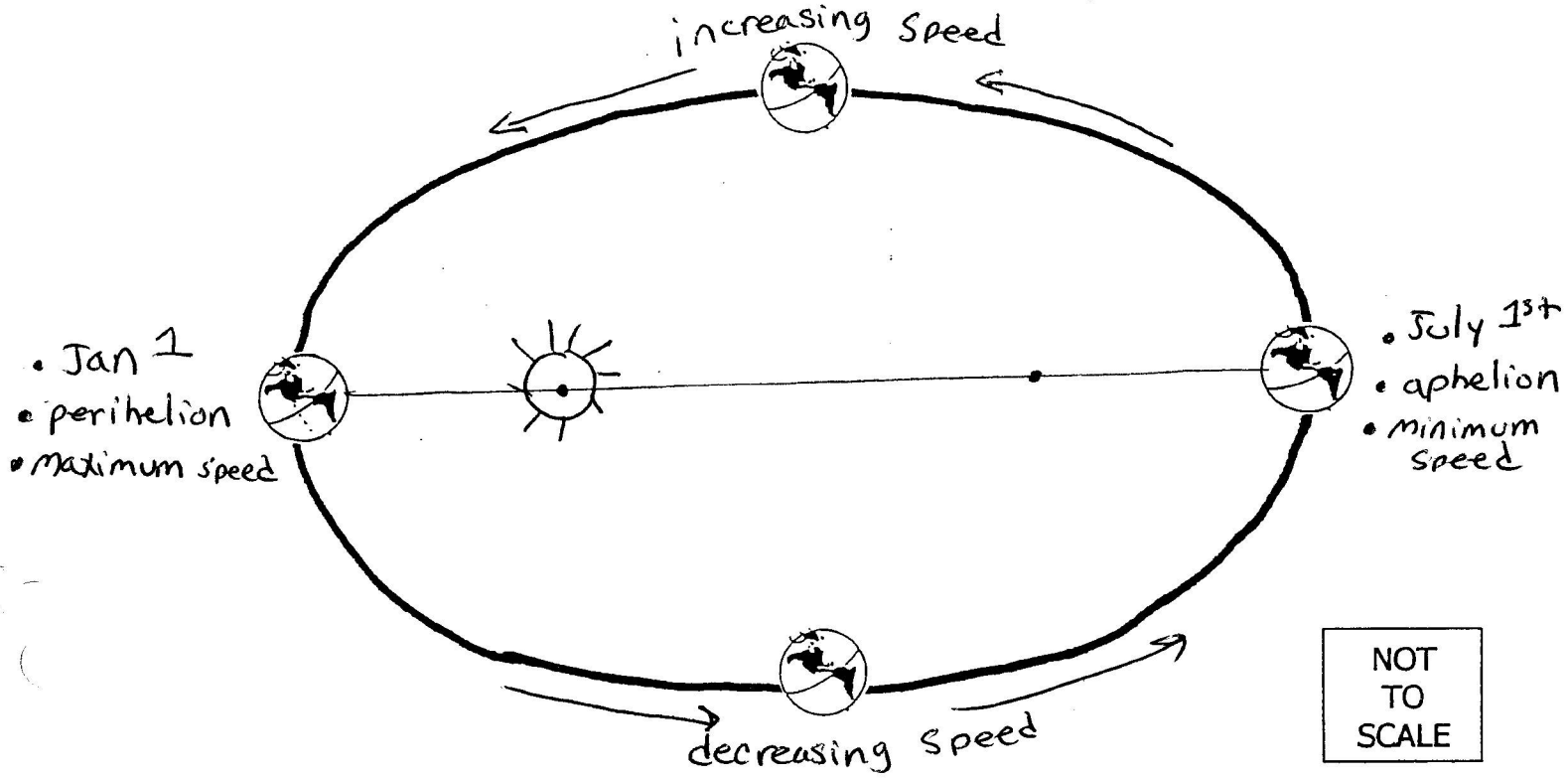


d. Relationship: As the distance between foci increases, the shape of the ellipse becomes more elliptical / oval.

e.



B. **Law 2** As a planet orbits the sun, its orbital speed changes; it is fastest when closest to the sun.

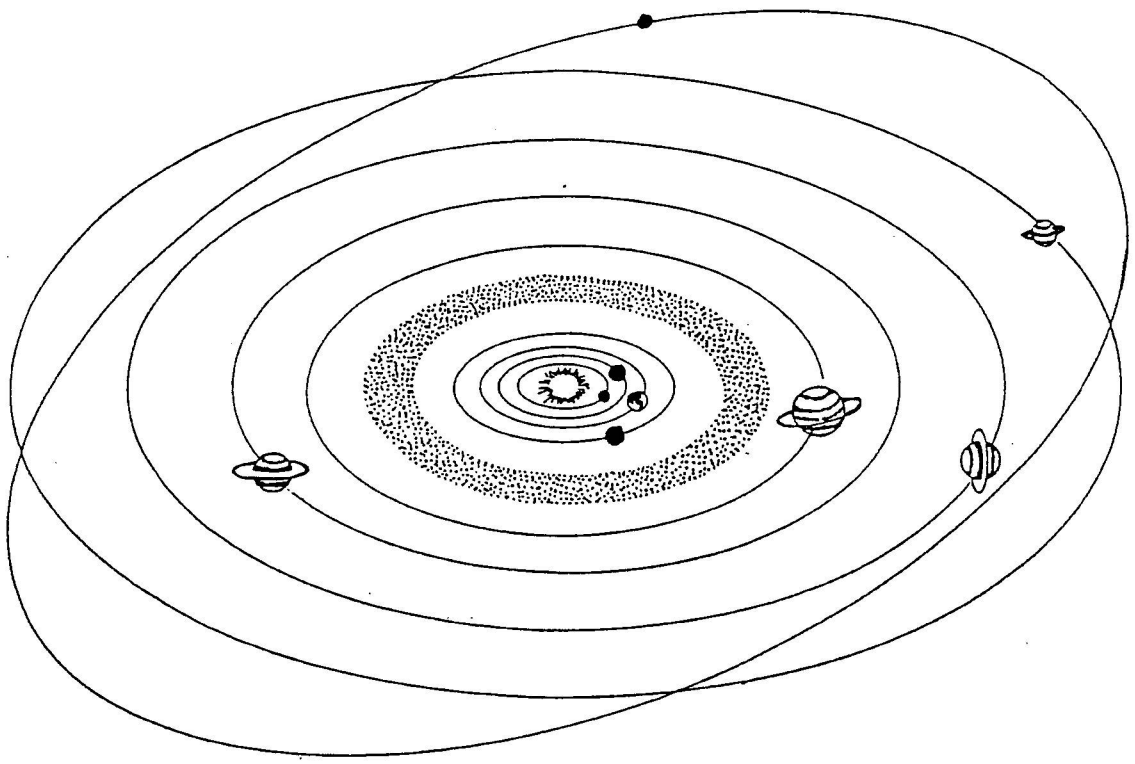


1. perihelion = point in orbit nearest to Sun
2. aphelion = point in orbit farthest from sun

C. **Law 3** the farther a particular planet is from the sun, the longer its period (time) of revolution.

1. farther planets have longer, orbital paths.
2. farther planets have slower orbital speeds.

3. Solar System



4.

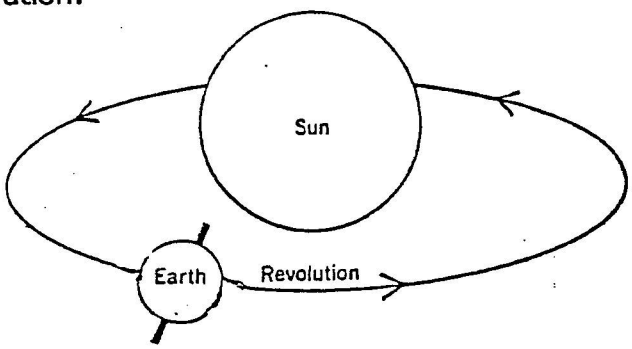
PLANET from Sun outward	DISTANCE FROM SUN millions of miles	(million km)	SPEED mi./sec	PERIOD OF REVOLUTION
Mercury	36	57.9	30	88 days
Venus	67	108.2	22	224 days
Earth	93	149.6	19	365 1/4 days
Mars	142	227.9	15	687 days
Jupiter	484	778.4	8	11.86 years
Saturn	887	1,426.7	6	29.46 years
Uranus	1784	2,871.0	4	84.01 years
Neptune	2795	4,498.3	3.4	164 years
Pluto	3675	149.6	3	247 years

VI. Revolution - the orbiting of one celestial body around another celestial body

A. Earth's Angular Rate of Revolution

THINK – one complete revolution:

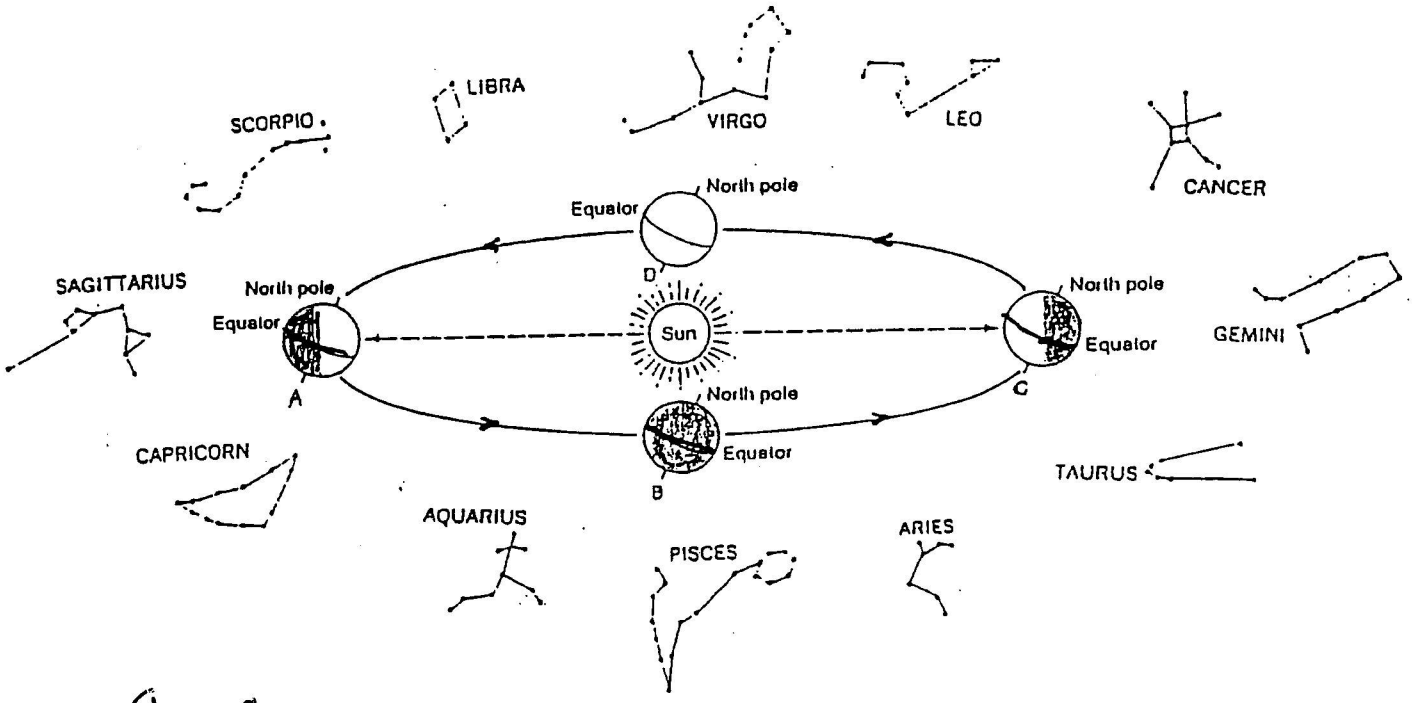
1. 360 degrees
2. 365 days



3. RATE = $\frac{360°}{365 da}$ = $1°/da$

B. Effects of Earth's Revolution

1. Nighttime constellations change in a yearly cycle.



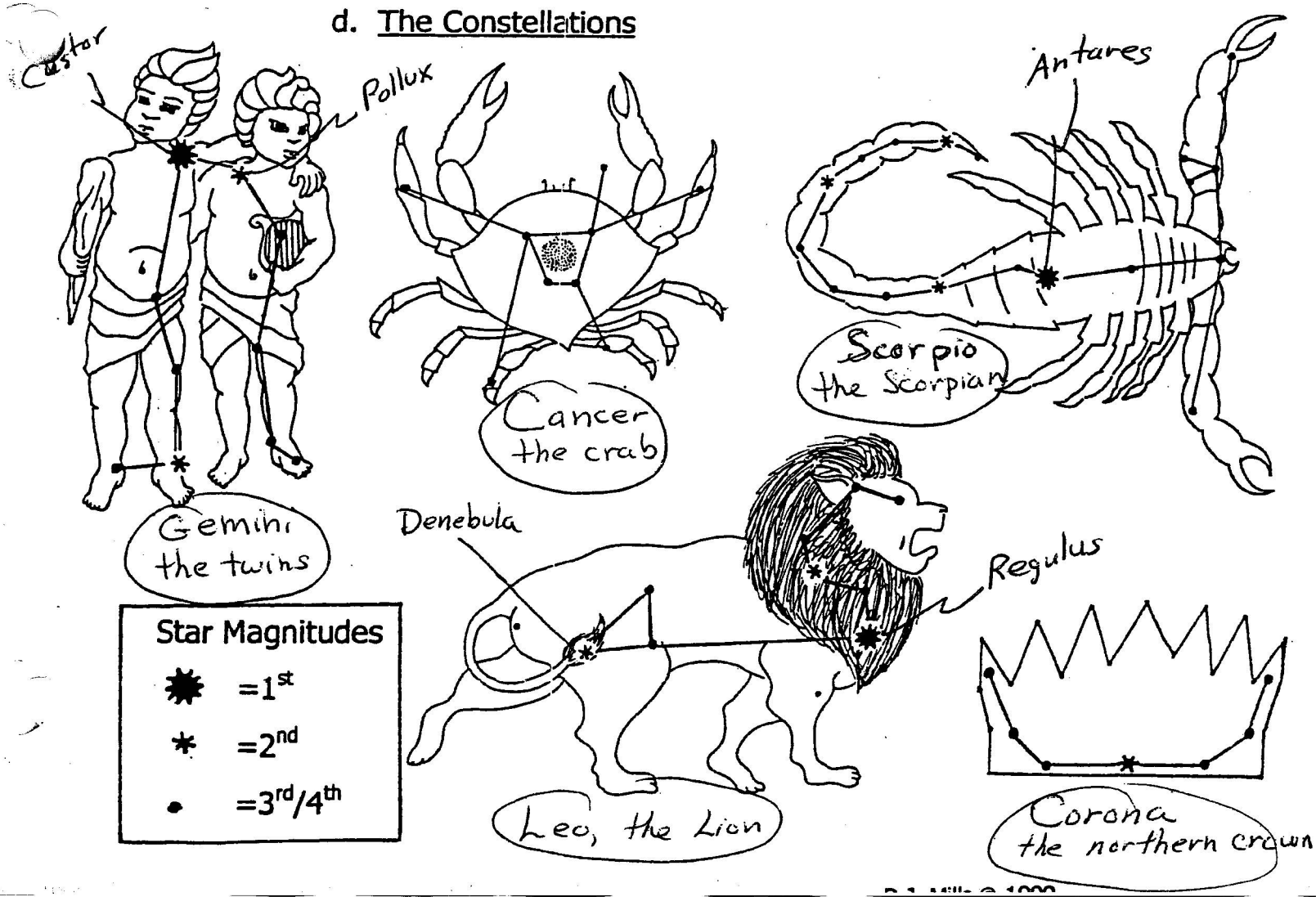
a. Constellation - group of stars that form patterns of imaginary things such as animals, legendary heroes and mythological characters.

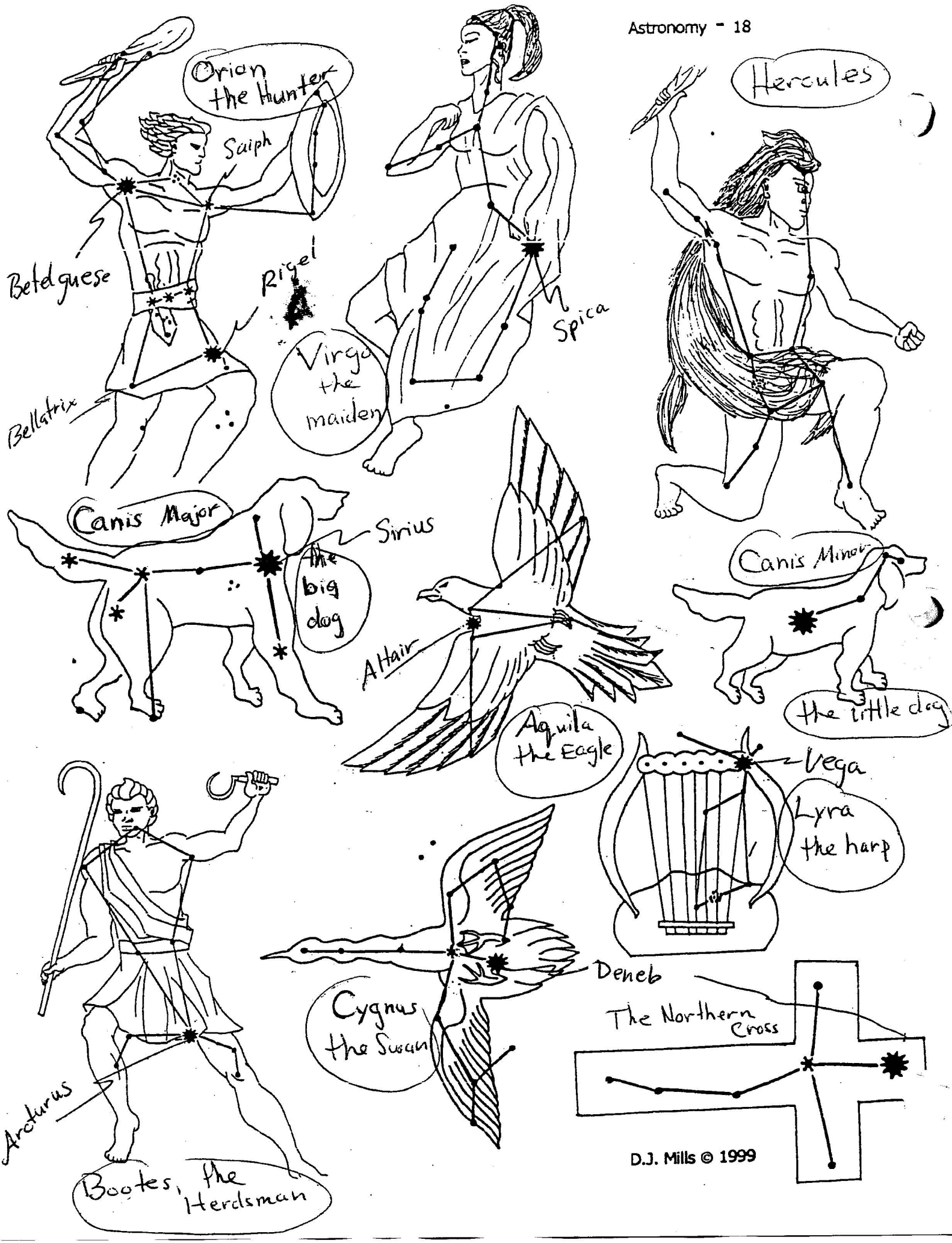
b. Zodiac – a band of twelve constellations that forms a background for the Sun as seen from the revolving Earth.

c. Complete the data table below based on the diagram on the preceding page.

POSITION OF EARTH	SEASON	CONSTELLATIONS VISIBLE AT NIGHT
A	summer	Scorpio, Sagittarius, Capricorn
B	fall	Aquarius, Pises, Aries
C	winter	Taurus, Gemini, Cancer
D	spring	Leo, Virgo, Libra

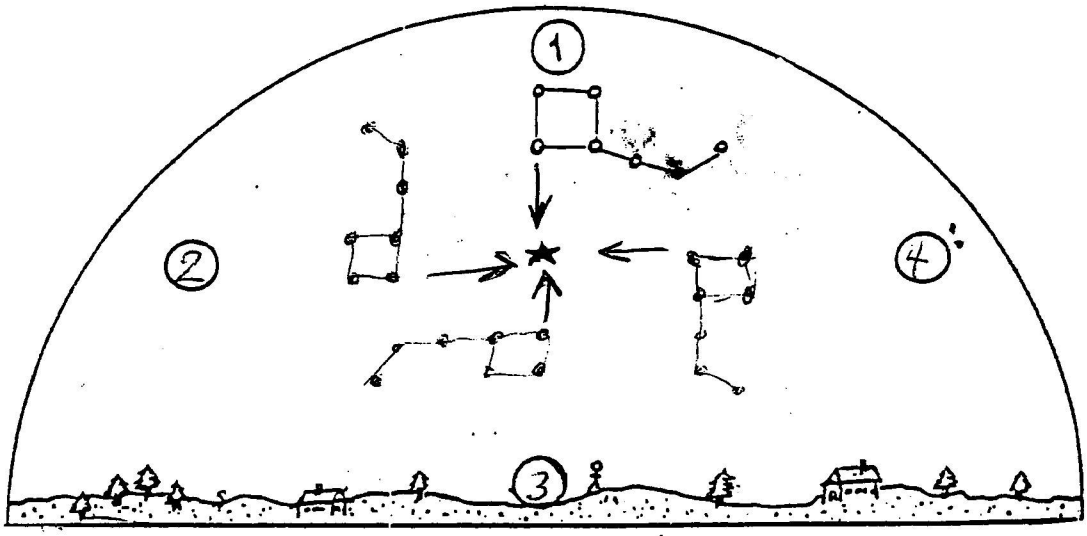
d. The Constellations




Orion the Hunter
Saiph
Betelguese
Rigel
Bellatrix
Virgo the maiden
Spica
Hercules
Canis Major
Sirius
The big dog
Altair
Aquila the Eagle
Canis Minor
the little dog
Vega
Lyra the harp
Deneb
Cygnus the Swan
The Northern Cross
Arcturus
Bootes, the Herdsman
D.J. Mills © 1999

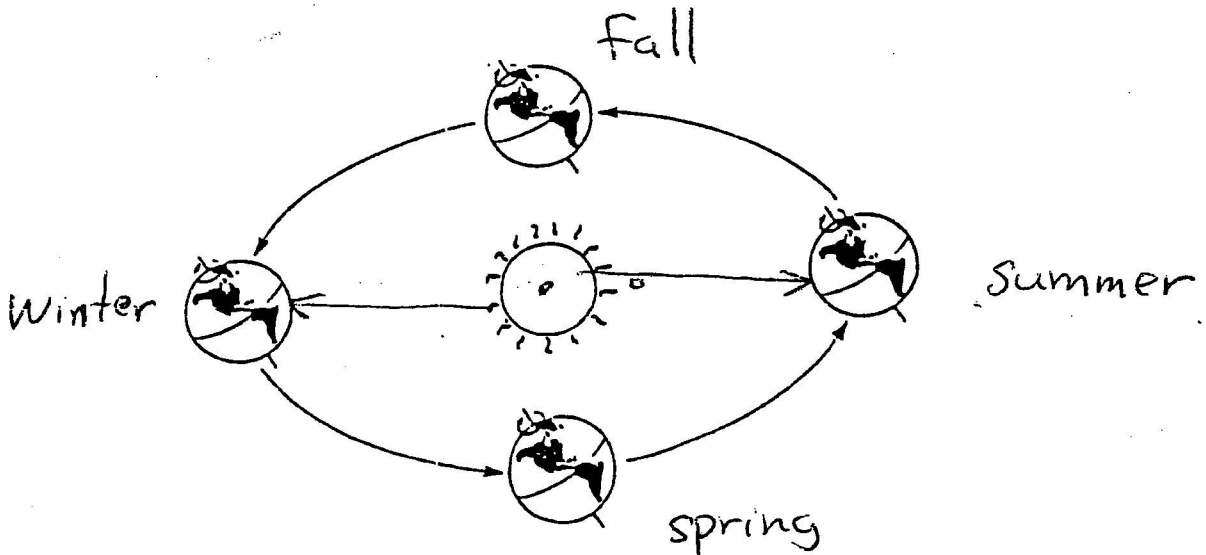
Continued: Effects of Earth's Revolution

2. Position of the Big Dipper (and other circumpolar constellations) changes position in a yearly cycle.



LOCATION OF OBSERVER		N. Y. S.
TIME OF DAY		9:00 p.m.
POSITION OF THE BIG DIPPER	FALL	1
	WINTER	2
	SPRING	3
	SUMMER	4

3. Seasons – a yearly cycle

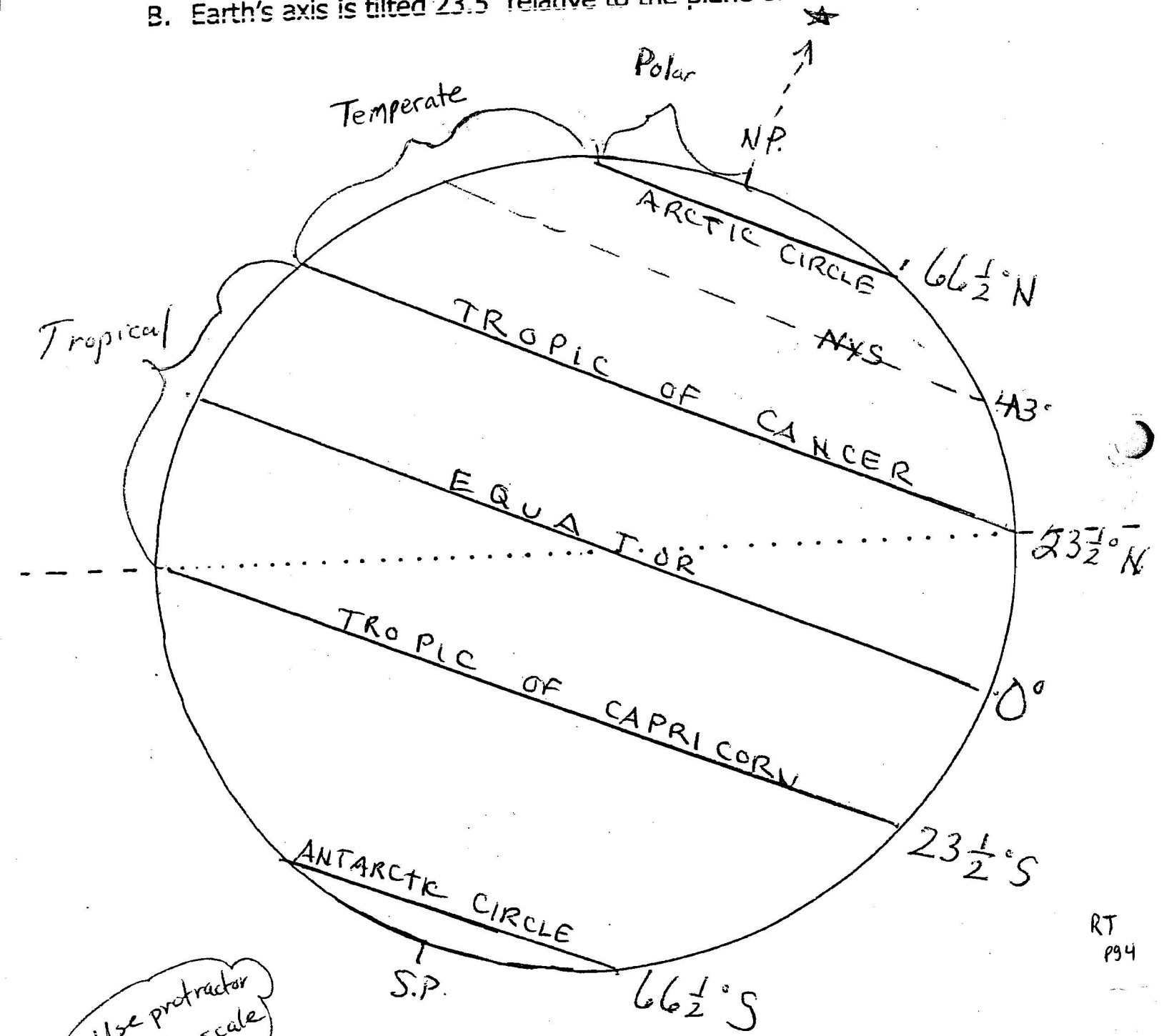


VII. SEASONS of the Year -

A. Causes:

1. Earth revolves around the Sun
2. Earth is tilted/inclined on its axis $23\frac{1}{2}°$
3. Earth's axis always points in the same direction

B. Earth's axis is tilted 23.5° relative to the plane of its orbit.

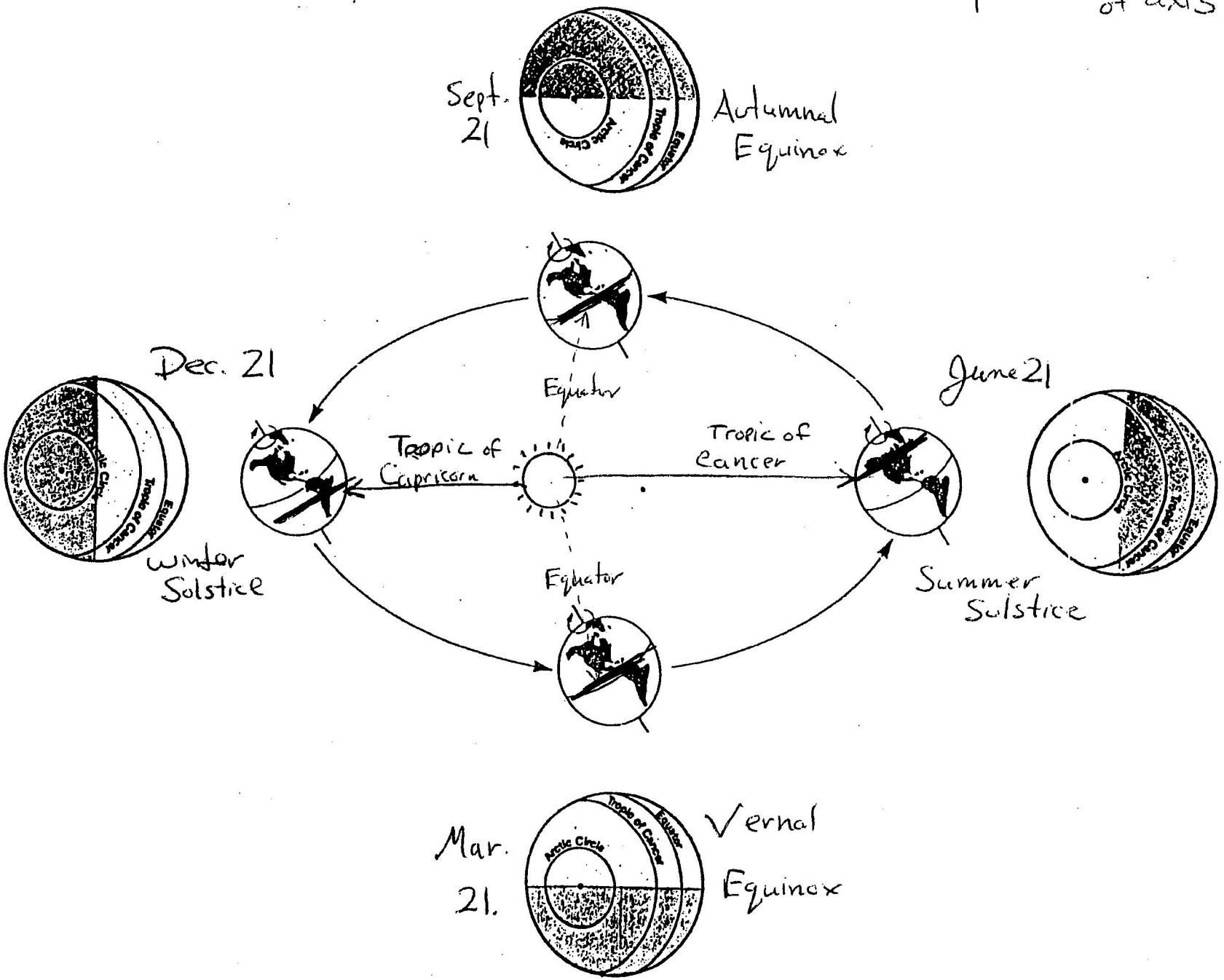


RT
P94

Use protractor draw to scale

C. Earth revolves around the Sun in a yearly cycle of 365¼ days.

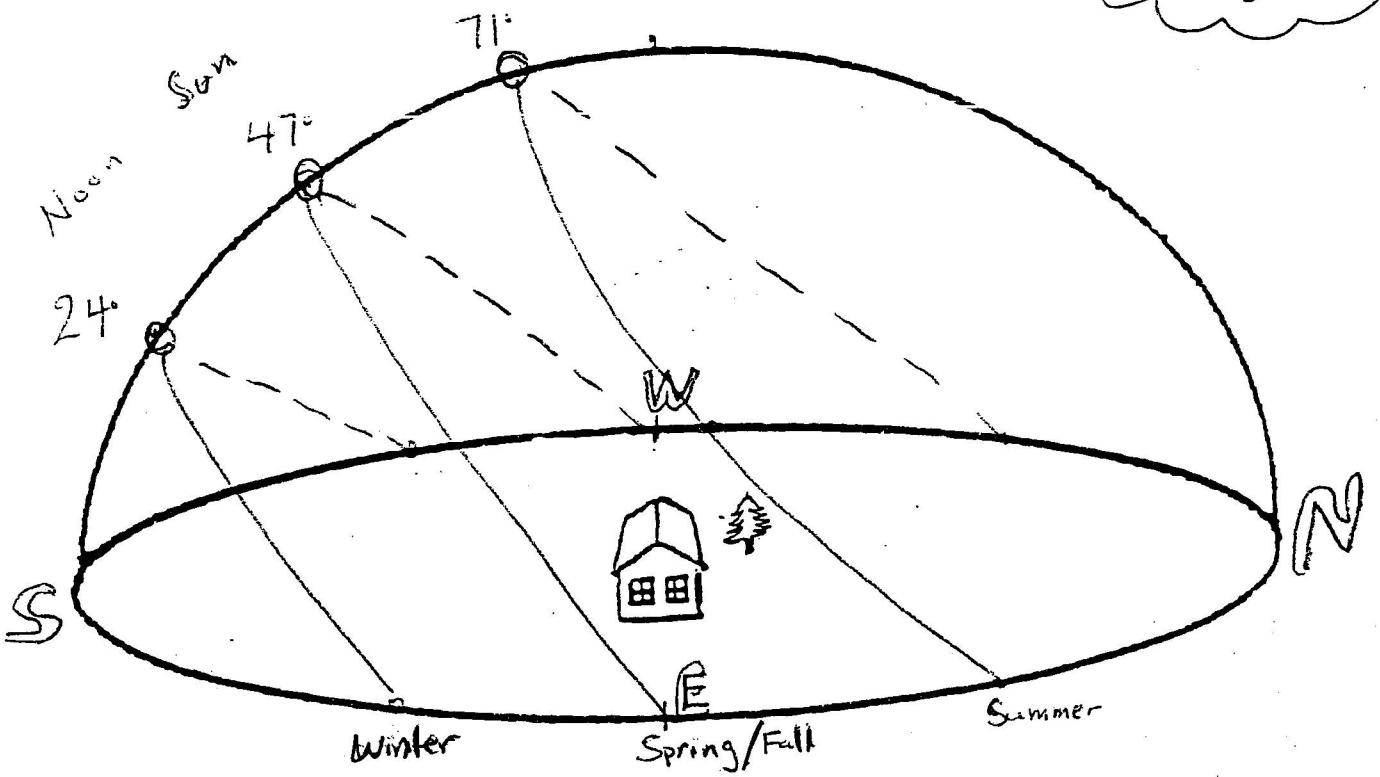
D. As Earth revolves, its axis always points in the same direction. – parallelism of axis



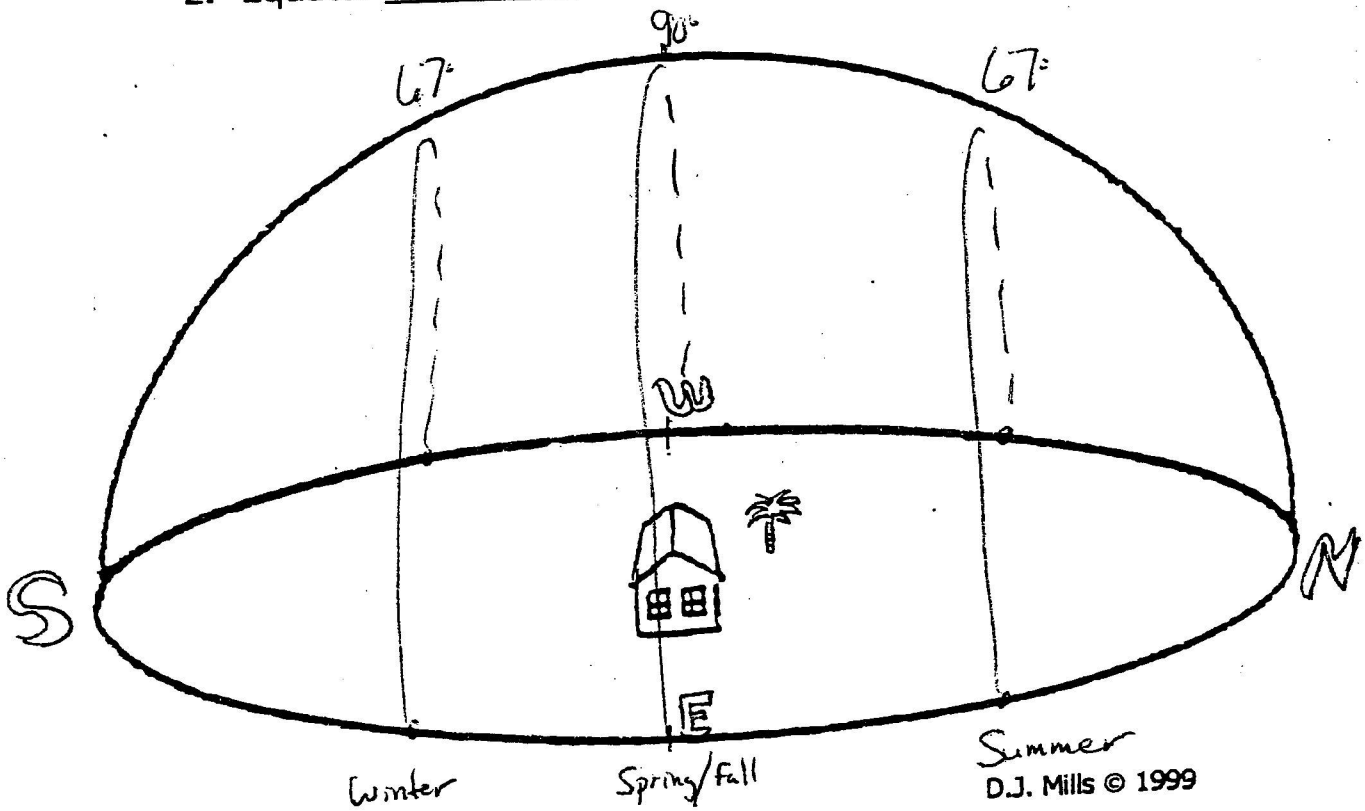
E. The apparent path of the sun changes with the seasons and with latitude.

After lab on Apparent Path of Sun

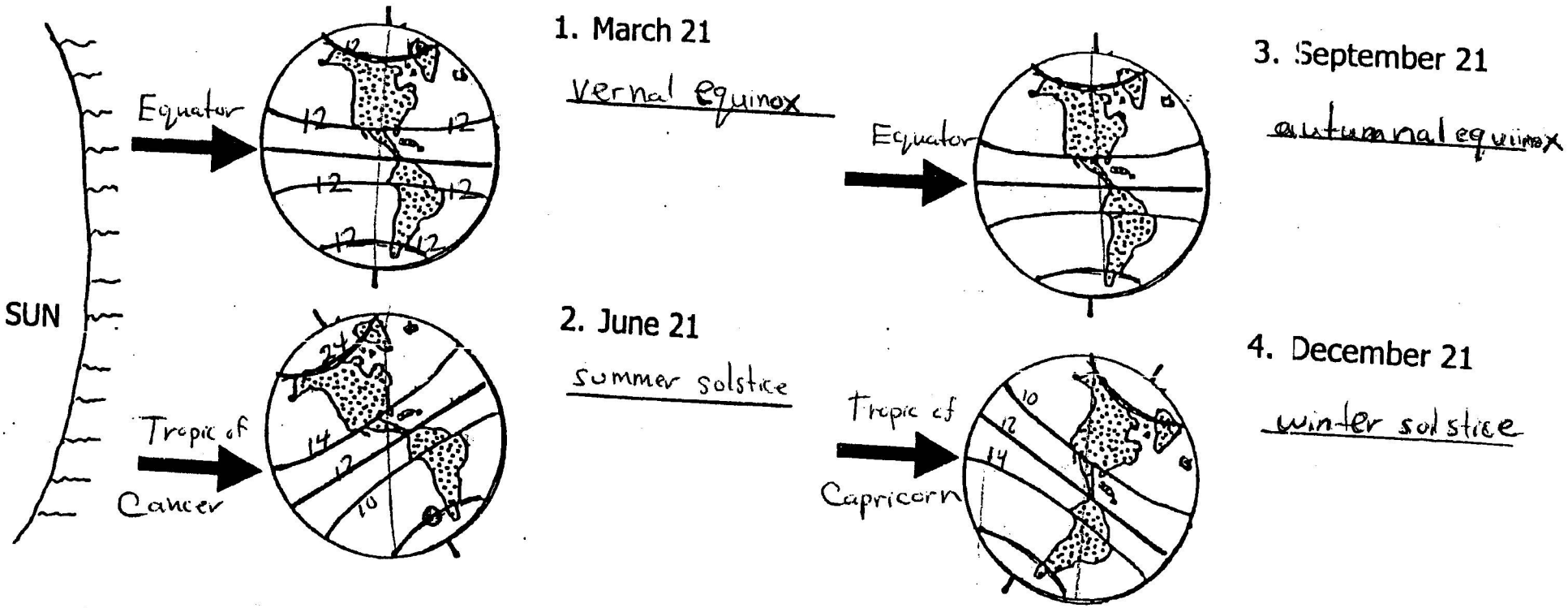
1. N.Y.S. 43° Latitude



2. Equator 0° Latitude



F. Length of Daylight (duration of d[illegible]) – changes with seasons and with latitude.



1. March 21
Vernal equinox

2. June 21
summer solstice

3. September 21
autumnal equinox

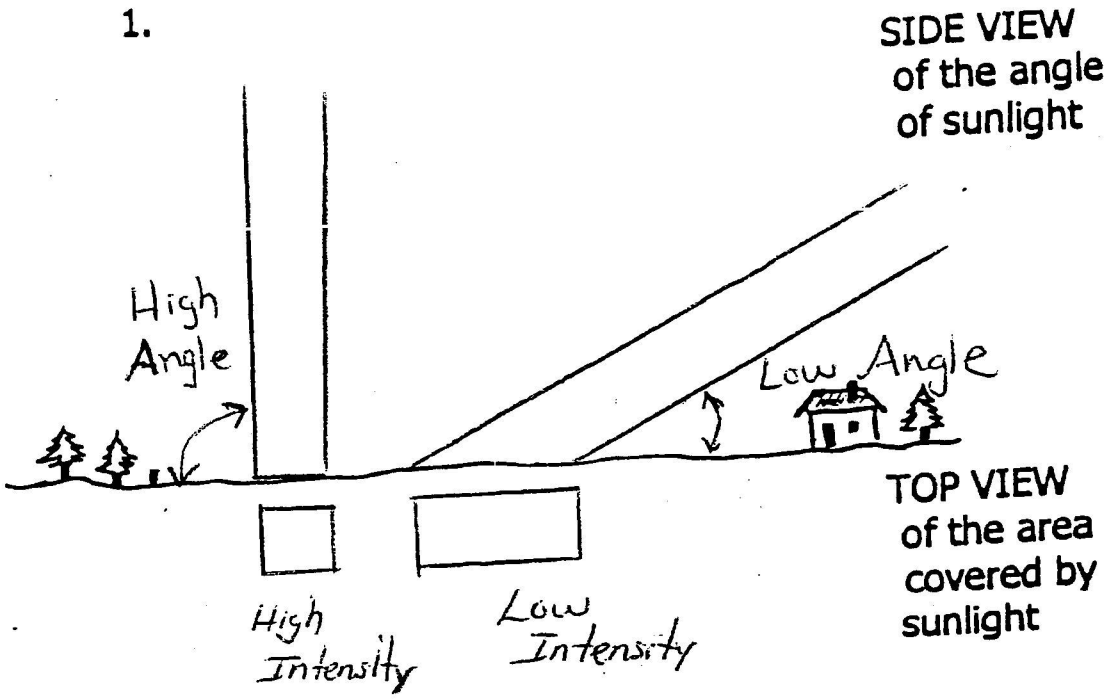
4. December 21
winter solstice

HOURS OF DAYLIGHT

LATITUDE	NORTH										SOUTH								
SEASON	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
1 March 21	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
2 June 21	24	24	24	18.5	16 1/4	15	14	13.25	12.5	12	11 1/2	10 3/4	10	9	7 3/4	5 1/2	0	0	0
3 Sept. 21	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
4 Dec 21	0	0	0	5 1/2	7 3/4	9	10	10 3/4	11 1/2	12	12 1/2	13 1/4	14	15	16 1/4	18 1/2	24	24	24

G. Angle of Insolation (sunlight) and Heating of Earth's Surface

1.

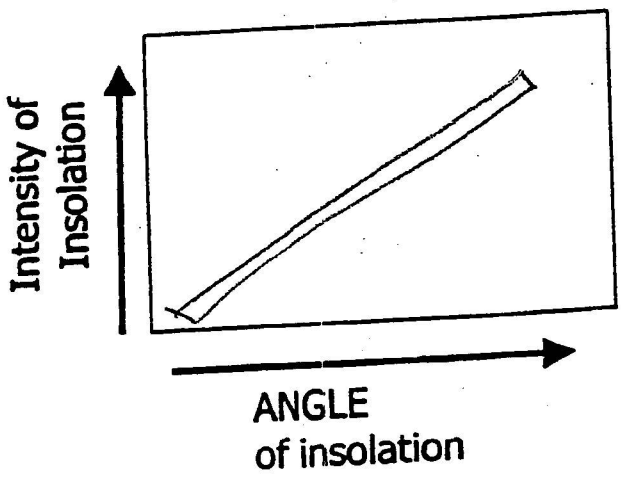


2. The intensity (strength) of insolation is greatest when sunlight (insolation) is perpendicular to the surface — striking at 90°.

because the sunlight is concentrated in the smallest possible area.

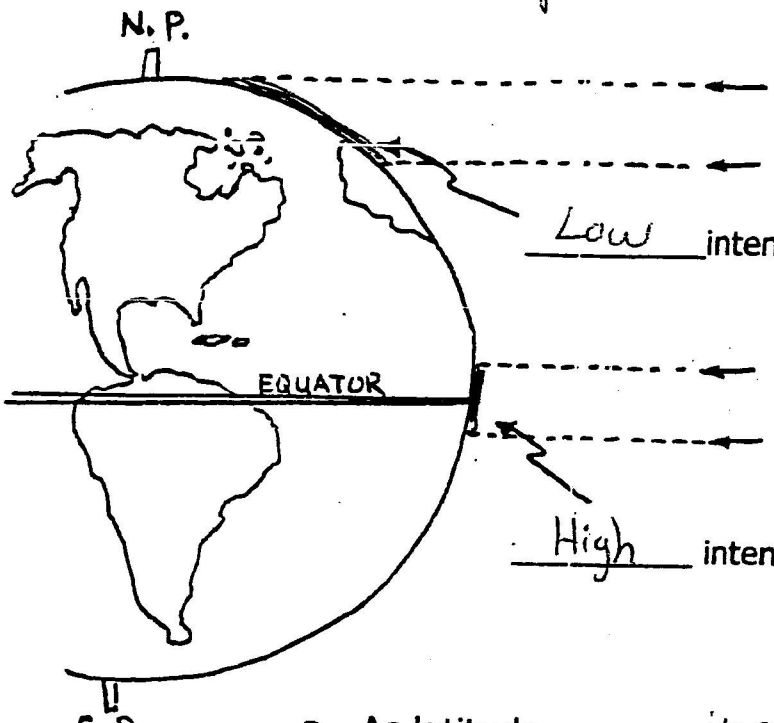
3. As the angle of insolation increases the intensity of insolation increases.

4.



H. Factors Affecting the Angle and Intensity of Insolation

1. Shape of the Earth



HIGH LATITUDES

Low angle of insolation

Low intensity of insolation

LOW LATITUDES

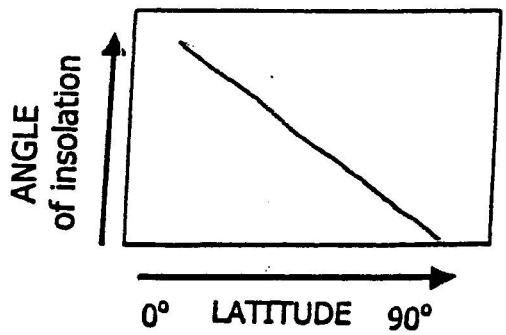
High angle of insolation

High intensity of insolation

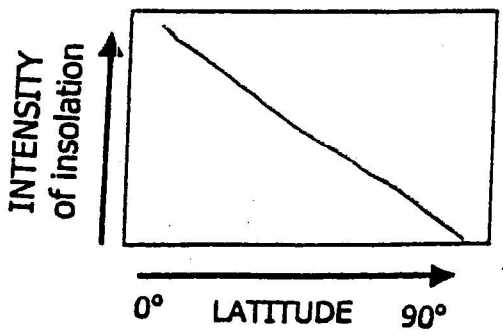
a. As latitude increases, the angle of insolation decreases, and the intensity of insolation decreases.

b.

1.



2.



H. Factors Affecting the Angle and Intensity of Insolation continued...

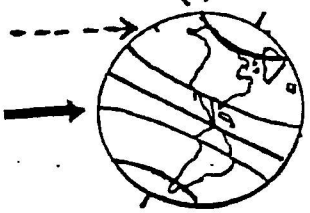
2. Season of the Year

a. As Earth travels along its orbital path around the Sun, the angle of insolation at a given latitude changes with the seasons. This depends on how far a given latitude is from the direct rays of the Sun. The direct rays migrate between the Tropic of Cancer and the Tropic of Capricorn.

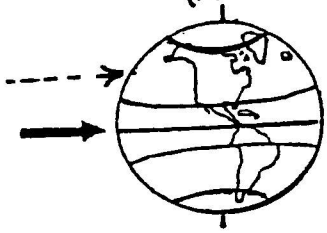
b. Key: ➡ Direct Ray of Sunlight (perpendicular to Earth's surface; 90°)

----→ Ray of Sunlight (striking N.Y.S. at an angle less than 90°)

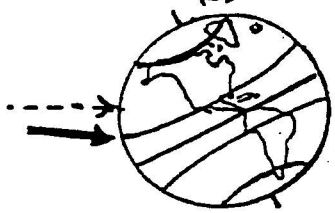
(1)



(2)



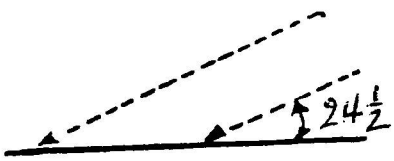
(3)



	(1)	(2)	(3)
LOCATION OF DIRECT RAY	T. Capricorn 23½ S. °	Equator 0 °	T. Cancer 23½ N. °
DATE	Dec 21	Mar/Sept 21	June 21
SEASON	WINTER SOLSTICE	EQUINOXES	SUMMER SOLSTICE

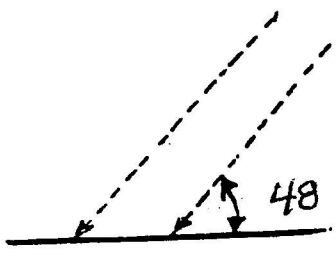
c. Maximum angle of insolation at 12 Noon for mid N.Y.S. (latitude 43°N)

1. Dec. 21



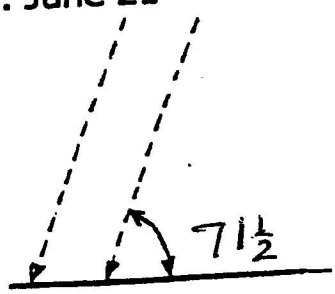
low angle
low intensity

2. Mar/Sept 21



medium angle
moderate intensity

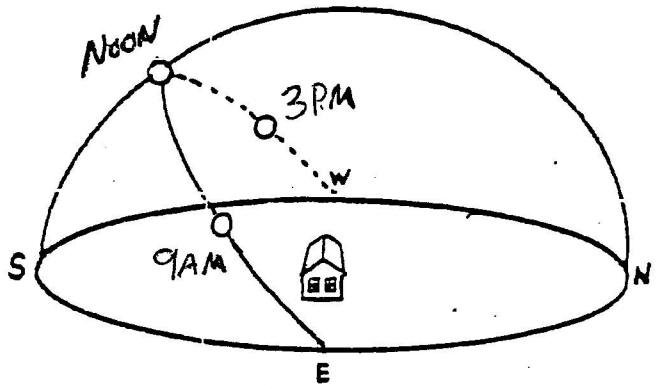
3. June 21



high angle
high intensity

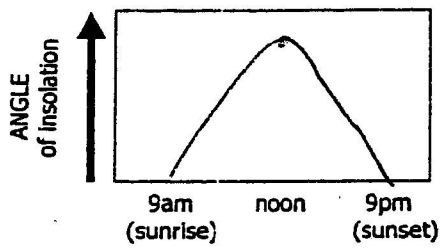
3. Time of Day

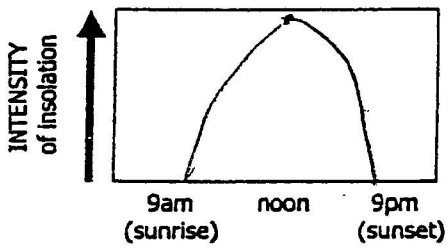
a.



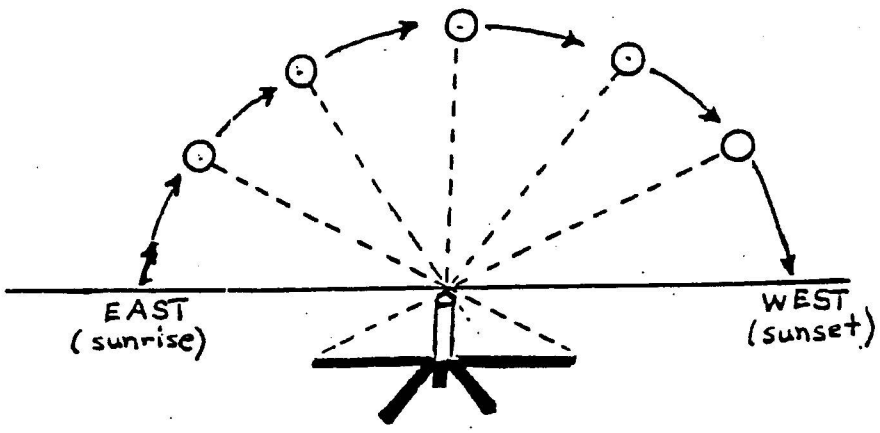
b. The angle of insolation changes in the course of one day. Maximum intensity occurs at NOON.

c.





d. Looking south



The shadow of a vertical pole indicates how the angle of insolation changes during the day. The higher/greater the angle of insolation, the shorter the shadow, and the greater the intensity of insolation.

VIII The Moon

A. The moon is a natural satellite of earth

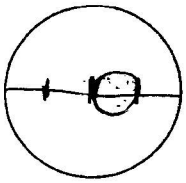
1. Luna - Latin word for the moon
2. Diana - Roman goddess of the moon

B. PHYSICAL PROPERTIES OF THE MOON

1. SIZE
   a. Diameter: 2160 miles
   b. Compared to Earth

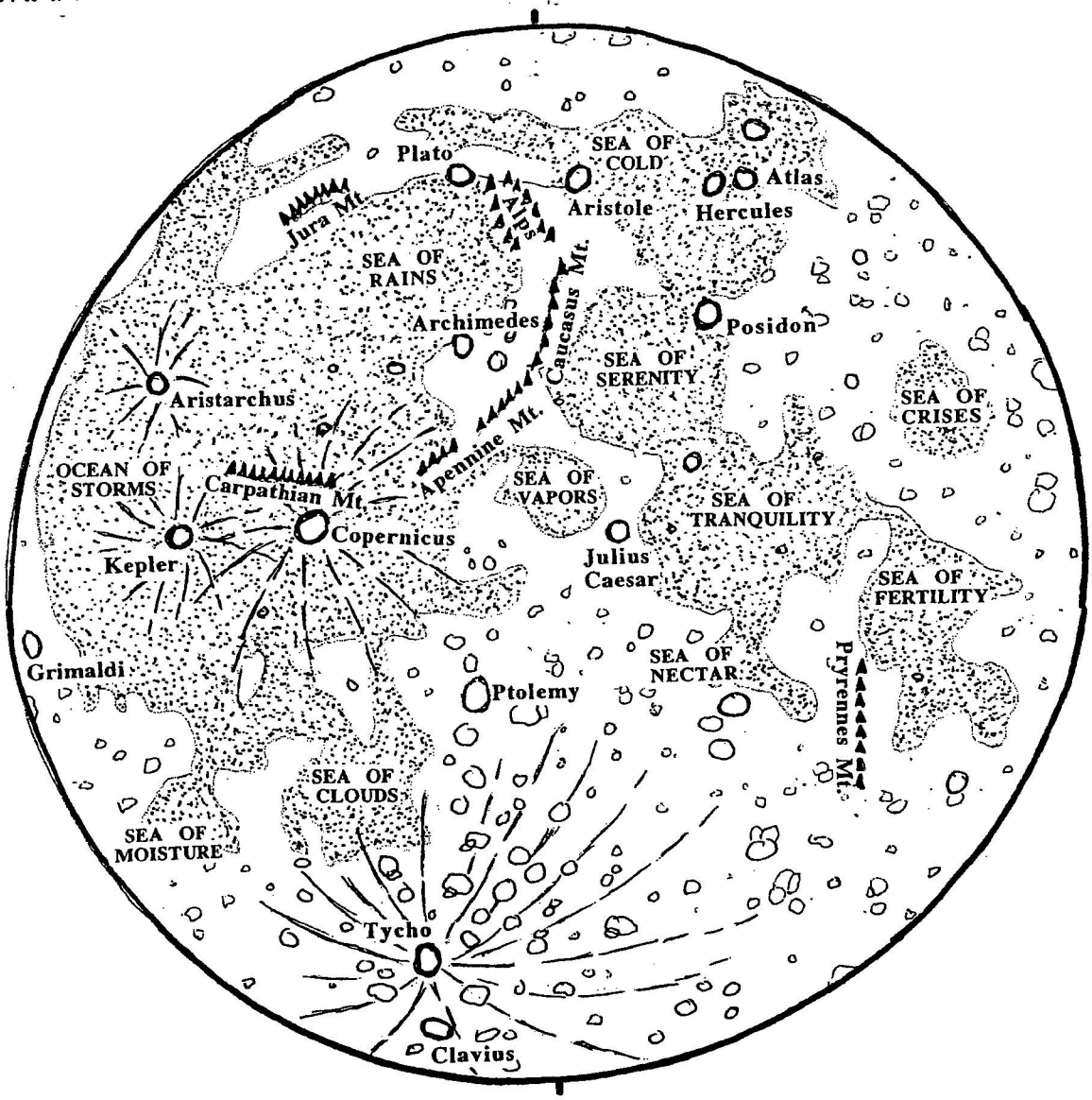
$$\text{Diameter of: } \frac{\text{MOON}}{\text{EARTH}} = \frac{2160}{8000 \text{ miles}} = \frac{1}{4}$$

   c. Scale of Size:



2. GRAVITY
   a. 1/6 the gravity of Earth
   b. smaller - less mass
3. ATMOSPHERE
   a. virtually none
   b. Gravity too weak - gases escape out into space
4. TEMPERATURES
   a. 240°F on the lighted side
   b. -240°F on the dark side
   c. These large temperature extremes or differences exist because the moon does not have an atmosphere to transfer heat.

C. LUNAR TOPOGRAPHY – surface features of the moon



1. Craters - bowl-shaped depressions formed primarily as a result of impact of meteors.

   a. Examples: Copernicus, Kepler Tycho Ptolemaeus

   b. There are many more craters on the moon than on Earth because the moon does not have an atmosphere to (1) burn up incoming meteors and (2) no cause erosion to wear them away

2. Maria - appear as the "dark areas" on the moon's surface; once thought to be "Seas".
   Extensive, circular, flat/smooth areas, or plains resulted from lava flows during a much earlier period of the moon's evolution.

   Examples:

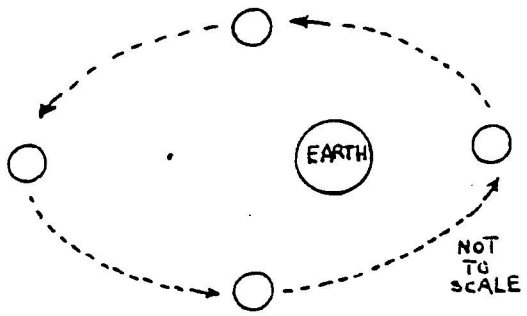
   Sea of Tranquility - Mare Tranquillitatis
   Sea of Showers - Mare Imbrium
   Sea of tears - Mare Crisium
   Sea of Clouds - Mare Nubium

3. Rays - appear as "bright streaks" that radiate from certain craters. Consist of shattered debris that was splashed out by the impact of meteors that formed the craters.

4. Highlands - appear as the "light areas" on the moon's surface. Consist of craters and mountains.
   Examples of lunar mountains: Alps, Jura, Carpathian, Apennine, Caucasus, Pyrenes

D. THE MOON'S REVOLUTION

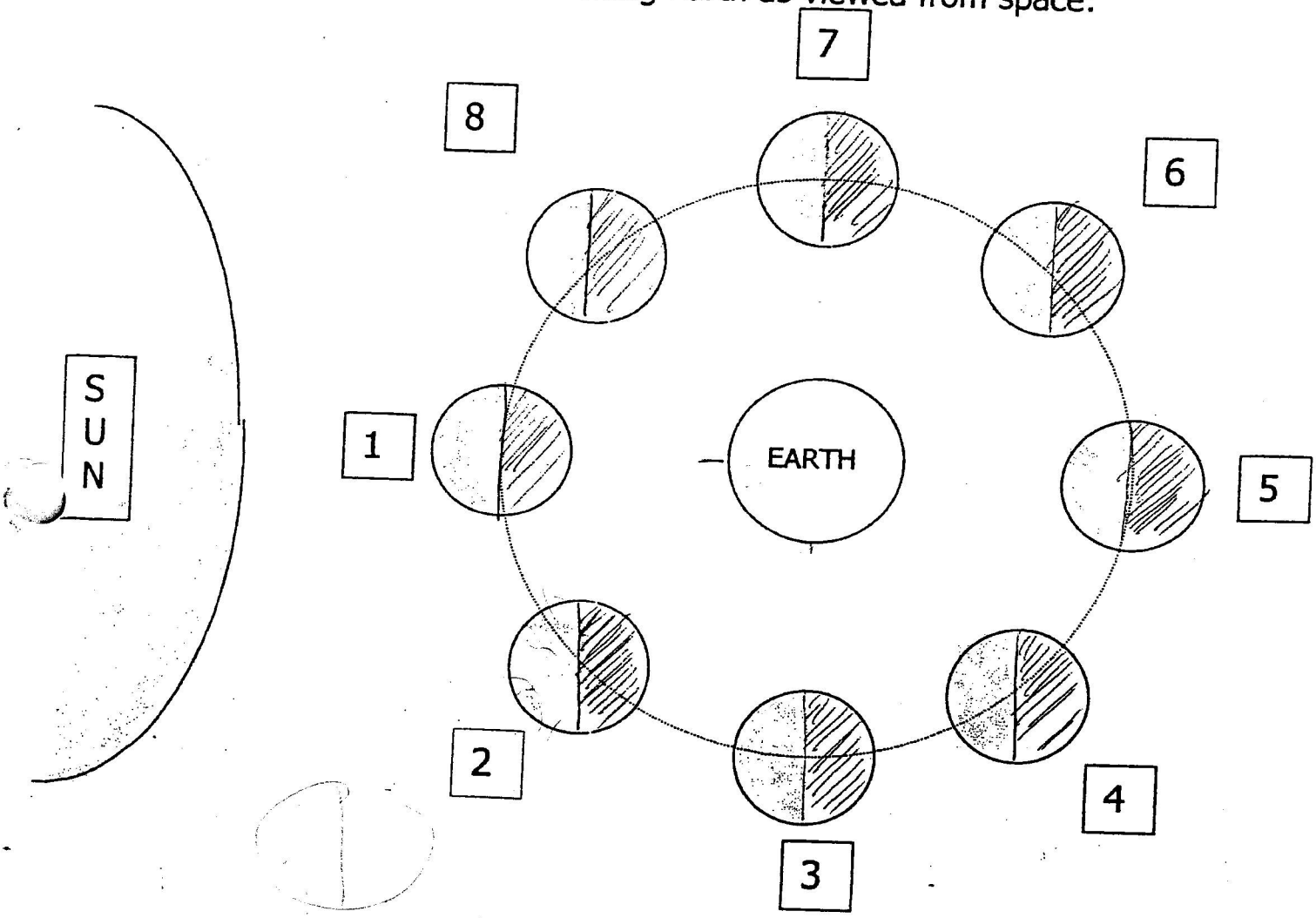
1. Period of Revolution
   a. 1 month
   or
   b. 29 1/2 days



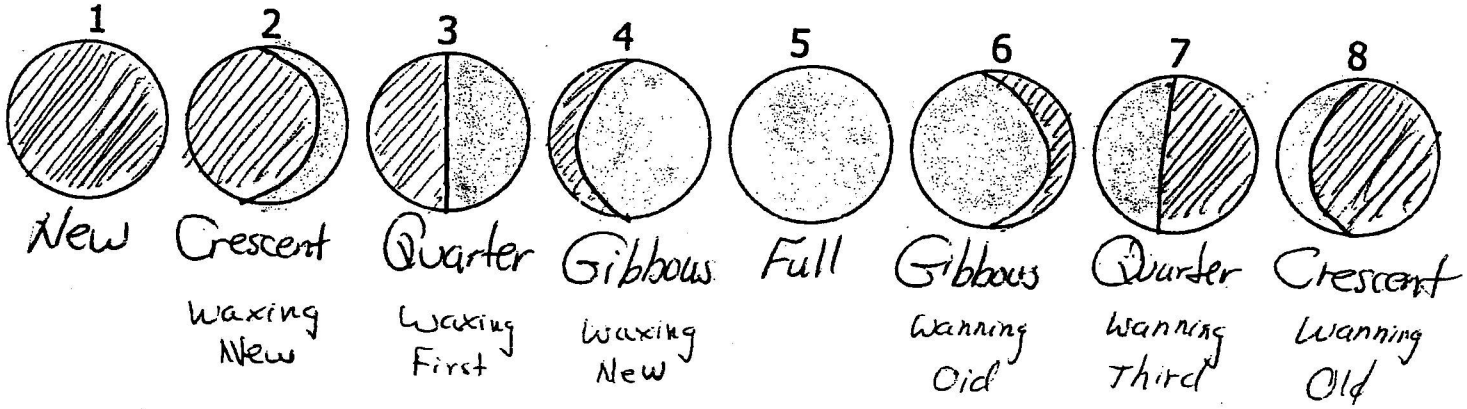
2. The moon revolves around Earth in an elliptical orbit, and Earth is at one foci.
3. This causes the moon's apparent diameter/size to change in a cyclic manner.

E. PHASES OF THE MOON

1. Caused by the moon's revolution around Earth
2. Our Earth view of the changing illuminated part of the moon's surface that faces Earth
3. a. The moon orbiting Earth as viewed from space:



b. Phases of the moon as viewed from Earth



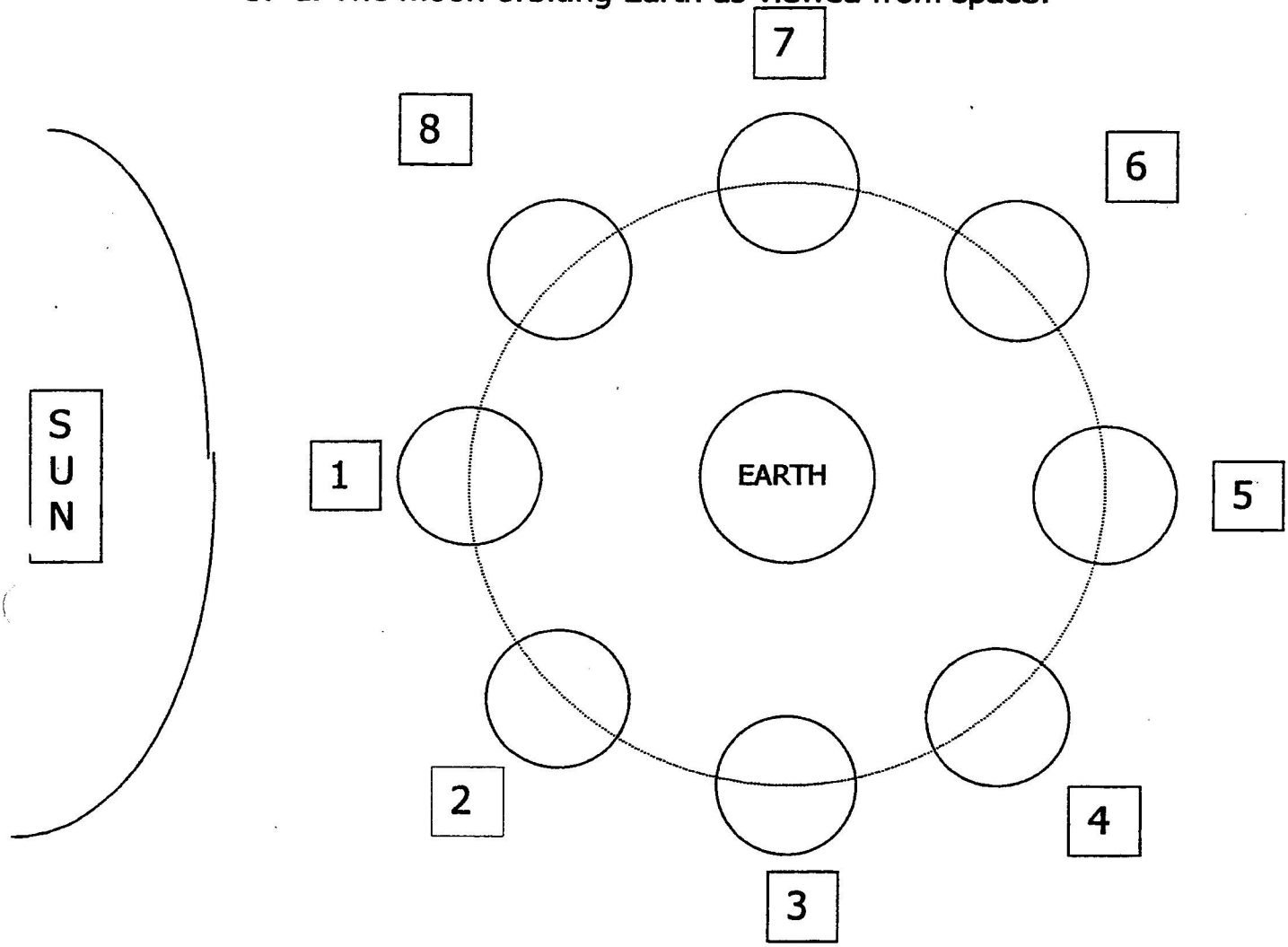
E. PHASES OF THE MOON

1. Caused by _____

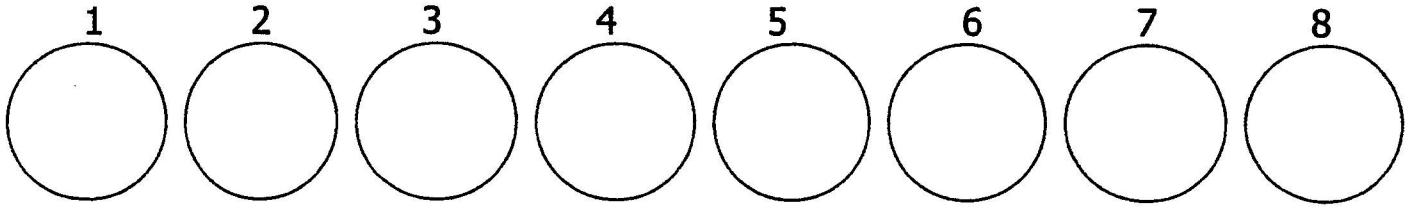
2. Our Earth view of the changing _____

_____

3. a. The moon orbiting Earth as viewed from space:



b. Phases of the moon as viewed from Earth



c. (1) Waning -the decreasing of the moon's visible illuminated surface; from full moon to new moon.

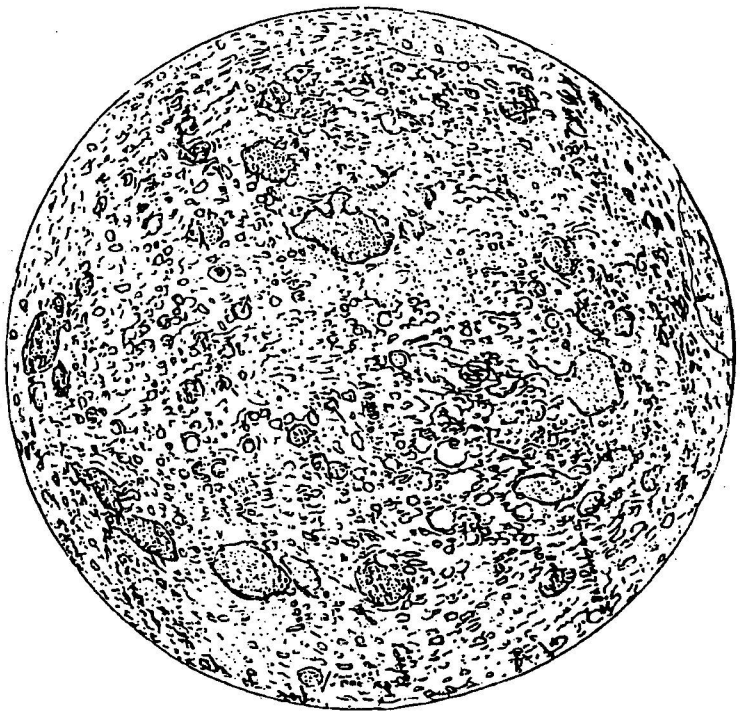
(2) Waxing -the increasing of the moon's visible illuminated surface; from new moon to full moon.

F. THE NEAR AND THE FAR SIDE OF THE MOON

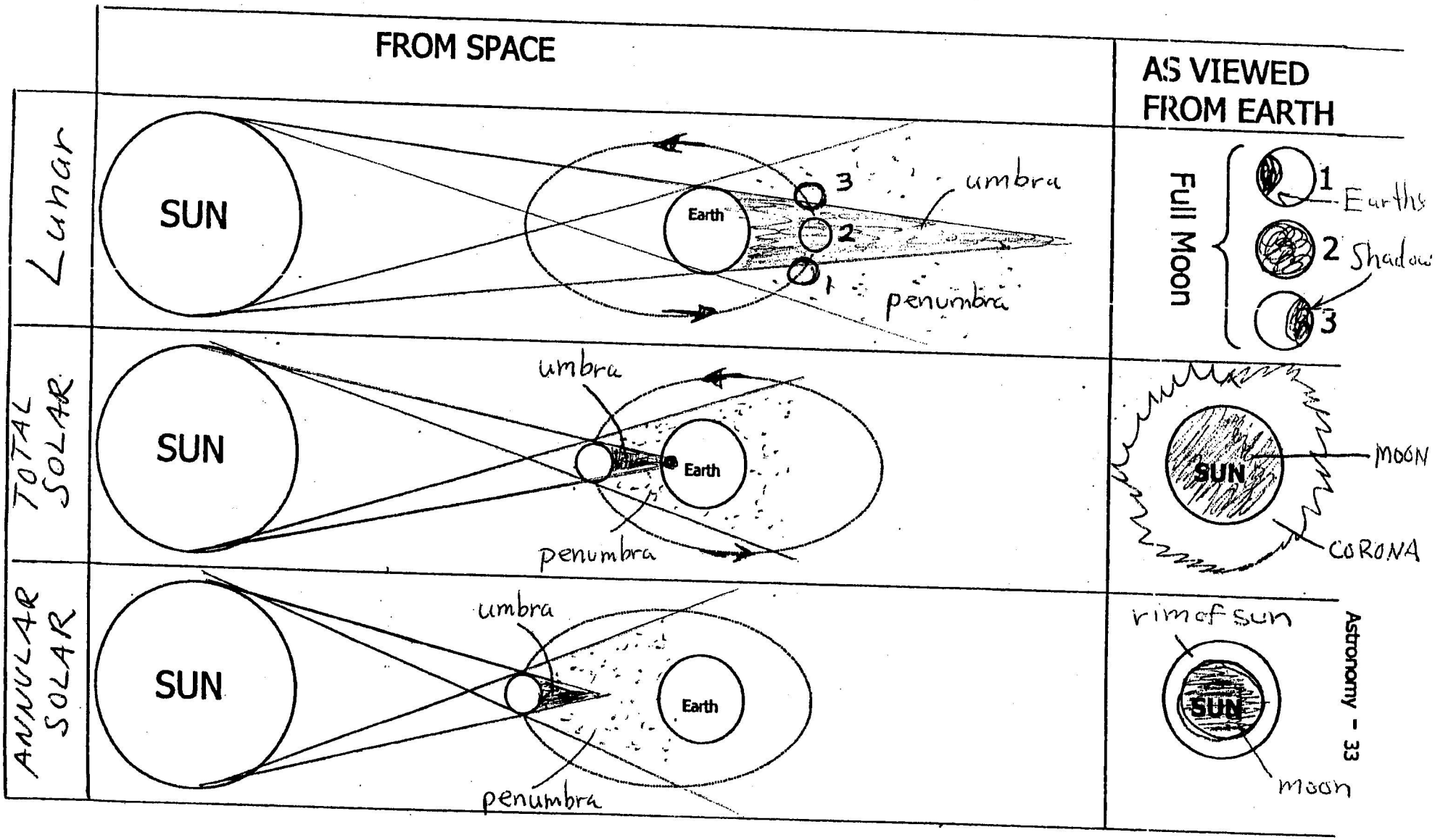
1. Near Side -the side of the moon that always faces Earth. It is nearly half highlands and half maria.
2. Far Side -the side of the moon that never faces Earth. It is mostly highlands/craters.
3. The same side of the moon (the near side) always faces Earth because: the moon's period of rotation equals its period of revolution

Near Side

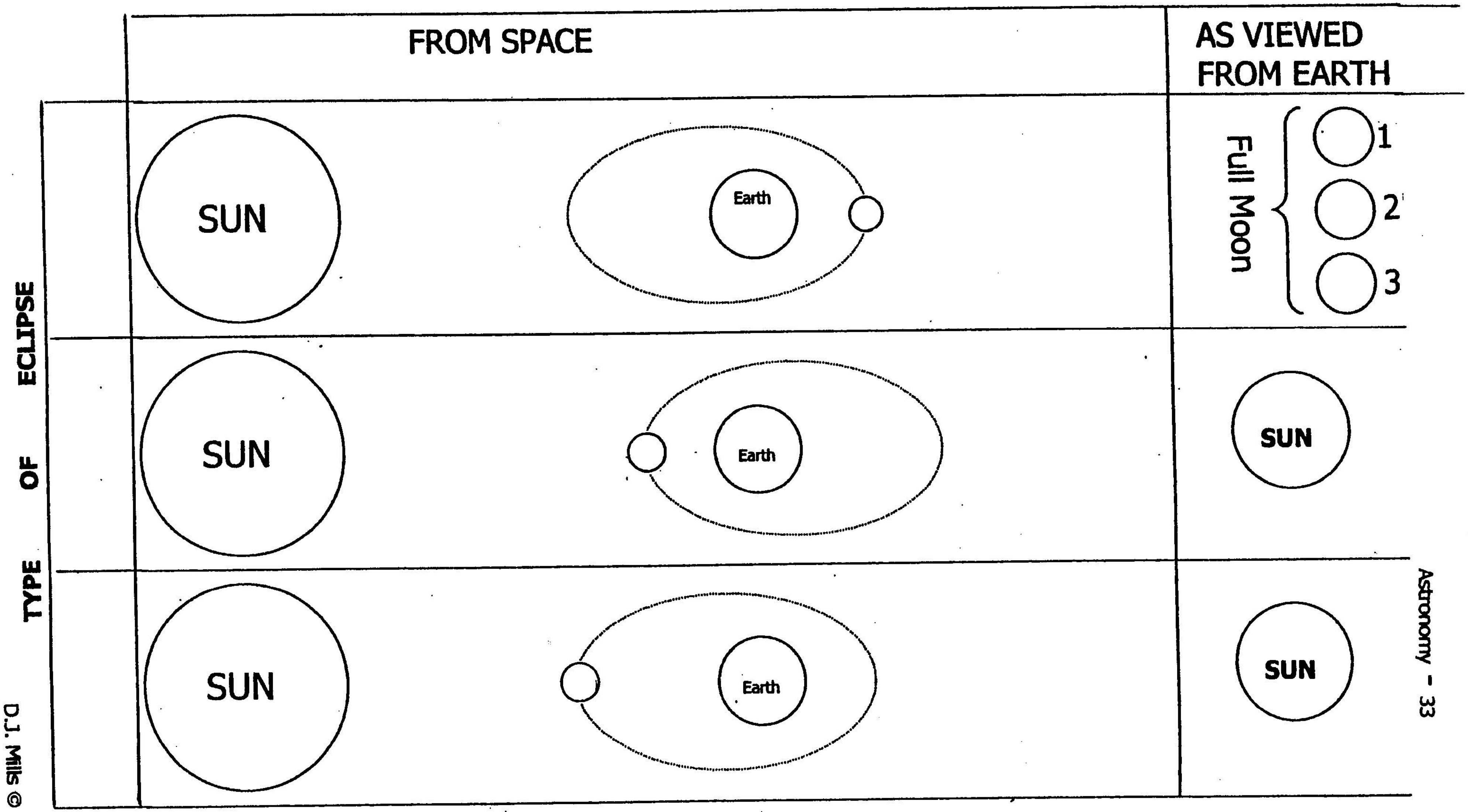
Far Side

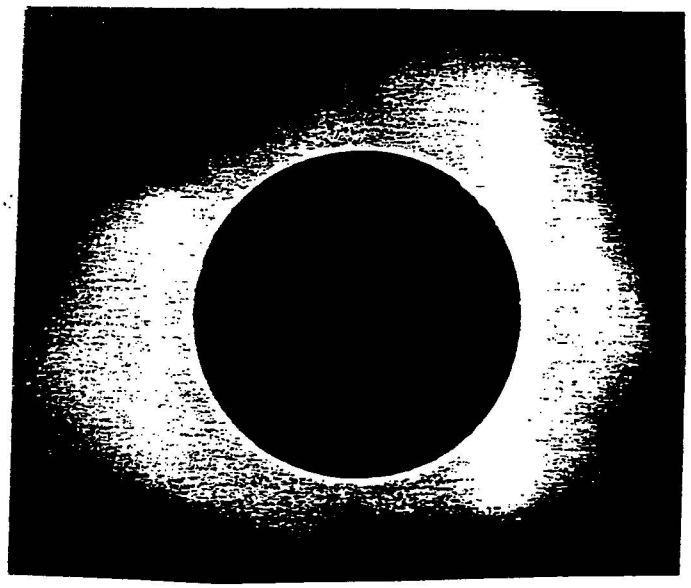


ECLIPSES


TYPE OF ECLIPSE
FROM SPACE
AS VIEWED FROM EARTH
Lunar
SUN
Earth
umbra
penumbra
1
2
3
Full Moon
1 Earths
2 Shadow
3
TOTAL SOLAR
SUN
Earth
umbra
penumbra
MOON
CORONA
ANNULAR SOLAR
SUN
Earth
umbra
penumbra
rim of sun
moon

ECLIPSES

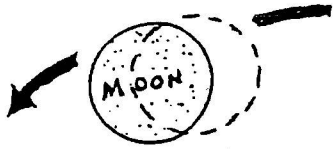


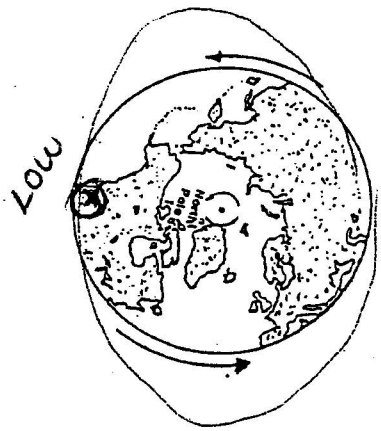


Totality
total eclipse of the sun

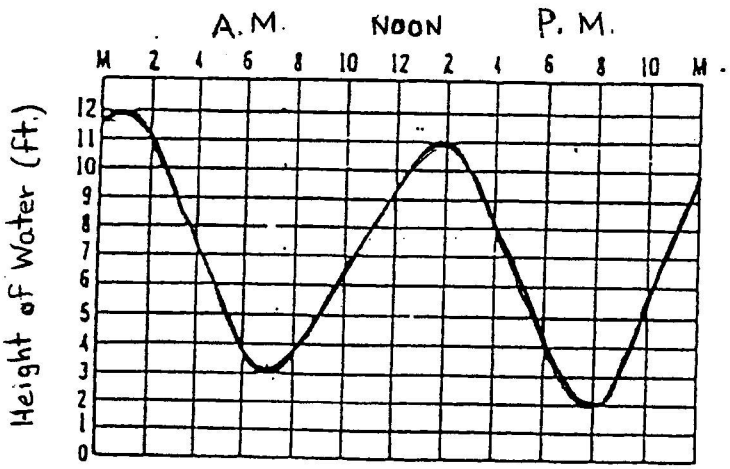
H. TIDES

1. Tides are the periodic rising and falling of the oceans
   a. Caused by the moon's gravity
   b. Affected by Earth's rotation





2. The period from high tide to high tide is normally about 12 hours and 25 minutes. It is a cyclic change.



a. The next high tide will occur at 3 am

b. The next low tide will occur at 9 am

Neap tide - when the Sun, Earth and Moon form a right angle (first quarter phase and third quarter phase) causing moderate tides

Spring tide - when the Sun, Earth, and Moon form a straight line (new moon phase and full moon phase) causing high tides to be a bit higher and low tides to be a bit lower.

IX EARTH'S PLACE IN THE UNIVERSE

A. Light Year

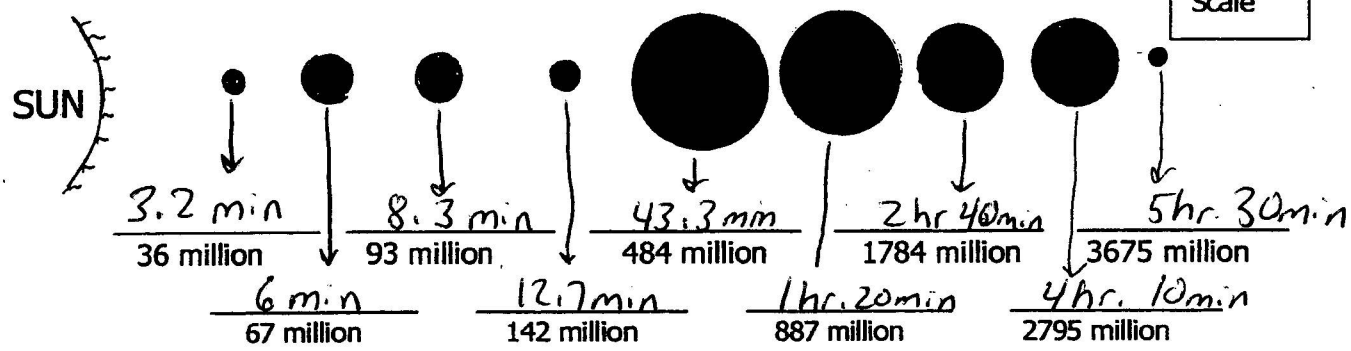
1. the distance light travels in one year

2. 6,000,000,000,000

3. The speed of light is 186 000 miles per second.

   a. The time is takes sunlight to reach each planet:

Not to Scale



   b. The time it takes sunlight to reach:

   (1) the nearest star Alpha Centauri = 4.3 years

   (2) the brightest star Sirius = 8.6 years

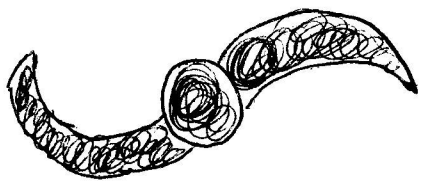
   (3) the nearby Andromeda Galaxy 2,000,000 years

B. Galaxies

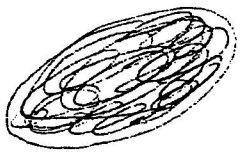
1. billions of stars held together by gravity

2. Shape of galaxies:

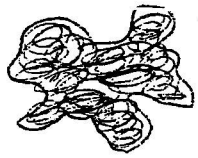
   a. Spiral



b. elliptical



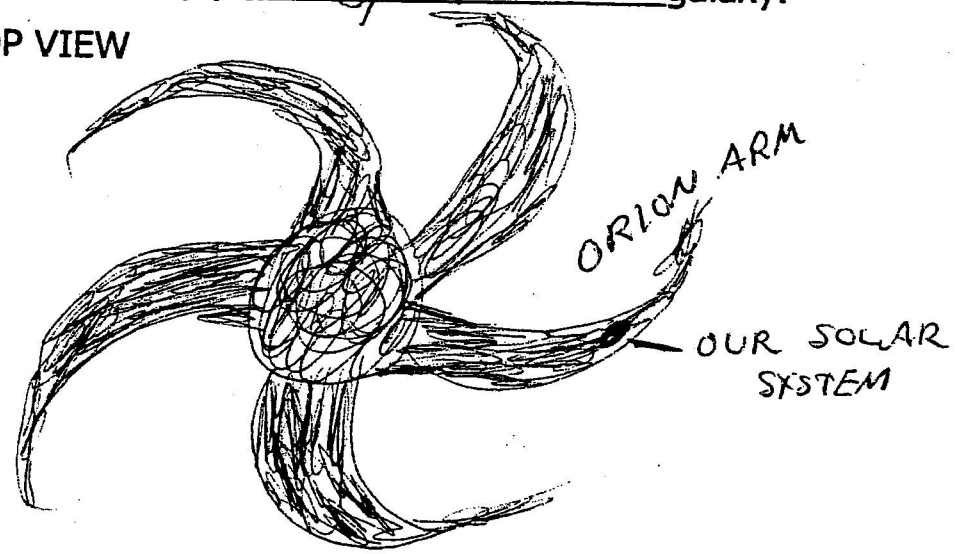
c. irregular



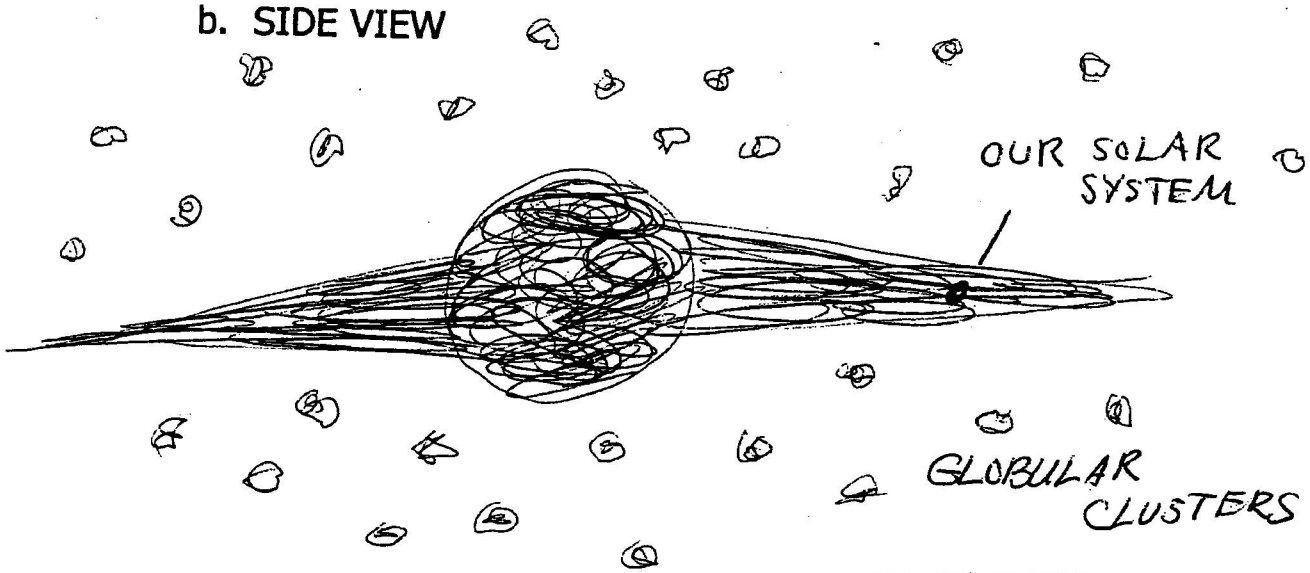
C. The Milky Way Galaxy

1. Our sun is only one of the estimated 180 billion stars that make-up the Milky Way Galaxy.
2. The milky way id a(n) spiral galaxy.

a. TOP VIEW



b. SIDE VIEW

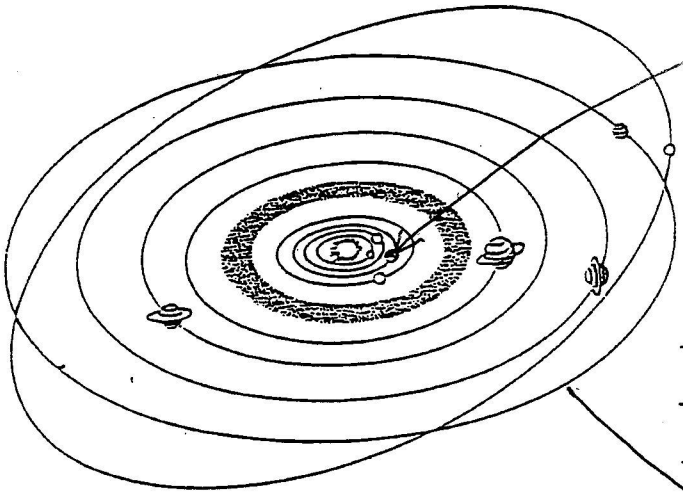


D. Levels of Structure of the Universe

...Earth's place in the Universe

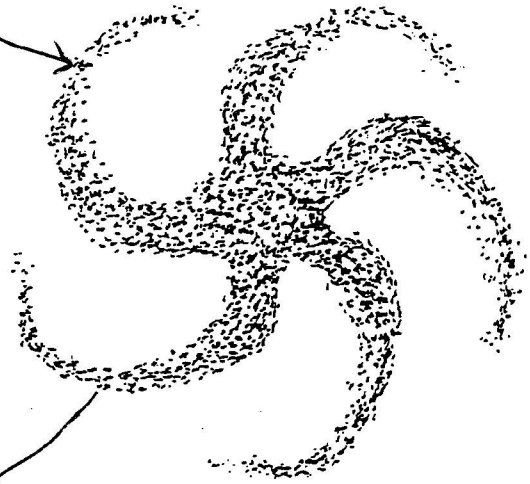
1. Planet Earth

a small dense rocky planet



2. Our Solar System

Earth is one of the eight planets, that orbit the sun - an average yellow star.



3. Milky Way Galaxy

Our sun / solar system is one of an estimated 180 billion stars making up this spiral galaxy

4. Universe

Our Milky Way Galaxy is one of billions of galaxies in an expanding universe.

E. Models of the Universe

1. Geocentric Model

a. About 2000 years ago, the Greek astronomer, Claudius Ptolemy developed a detailed model of the universe based on the idea of revolving spheres.

b. In this model of the universe, Earth was the center, and all heavenly bodies moved around Earth in perfect circles.

c. Ptolemy's geocentric model, as illustrated on the next page, can be summarized as follows:

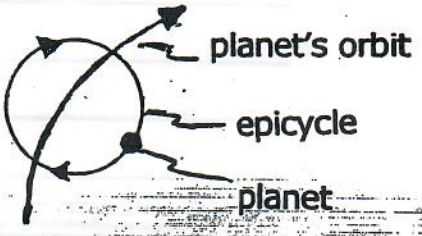
(1.) Earth is located in the center and does not move.

(2.) The Stars are located on a transparent sphere that rotates once each day from east to west around Earth.

(3.) The Sun, the moon and each planet are carried by separate spheres of different sizes. These spheres also rotate from east to west around Earth. (However, they rotate at slightly slower speeds than the sphere of stars and therefore have a general eastward drift relative to the stars. This explained the yearly cycle of nighttime stars.)

Claudius Ptolemy
100-178 A.D.

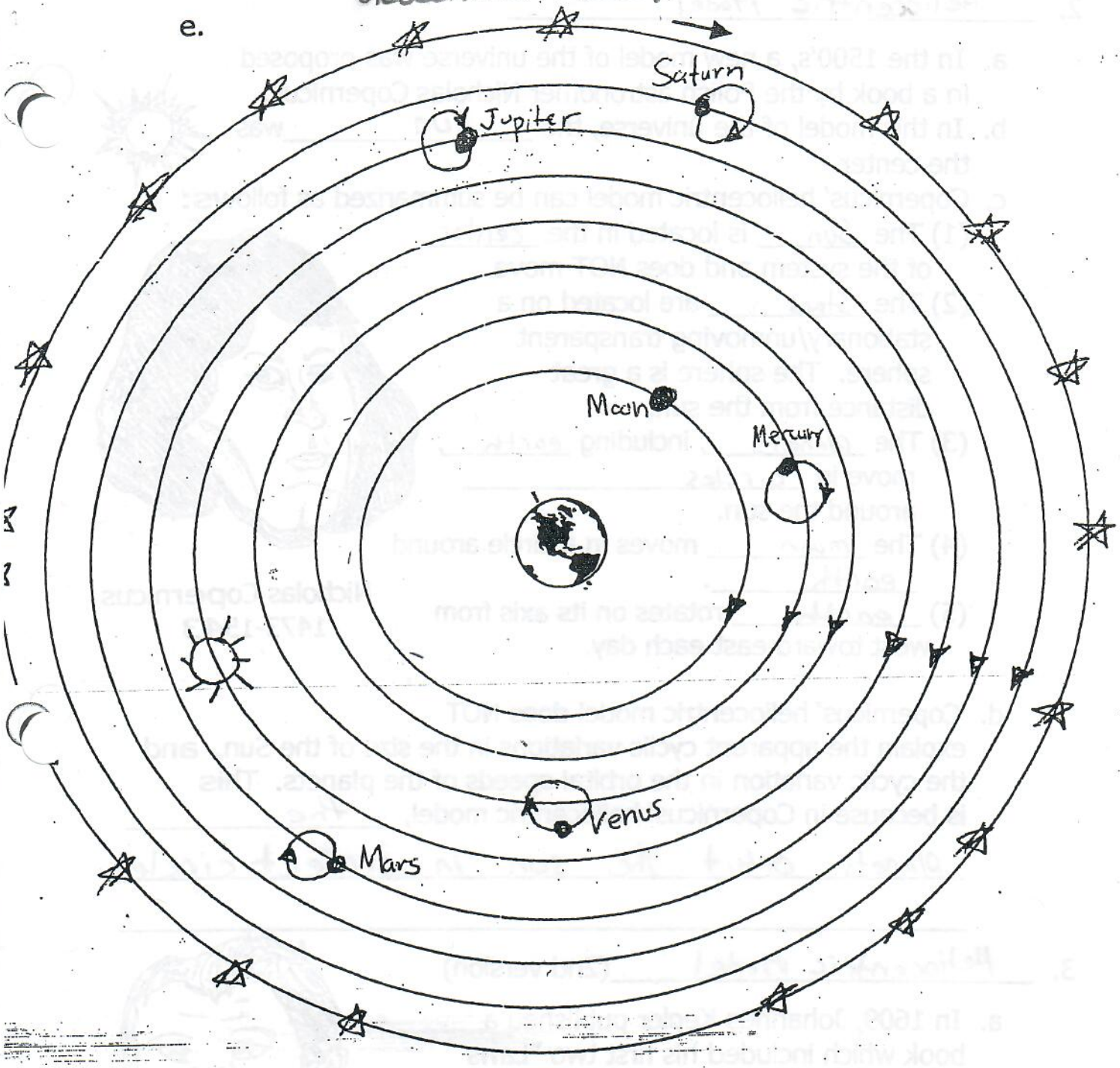
(4.) Each planet is located on an "epicycle" (or epicircle) that also rotates. So as each planet moves around Earth on its sphere, it is also moving or rotating on its epicycle. (This explained the strange "retrograde motion" of the planets relative to the background stars. That is, the planets seemed to move backward compared to the stars when you observed them for several weeks)



d. This model was accepted for almost 1400 years because it explained celestial observations made from Earth and it seemed so obvious.

Geocentric model

e.



f. The geocentric model does NOT explain terrestrial (Earth) observations such as:

1. the movement / rotation of a pendulum's direction
2. the curvature of the paths of projectiles, winds & ocean currents

2. Heliocentric Model

a. In the 1500's, a new model of the universe was proposed in a book by the Polish astronomer Nicholas Copernicus.

b. In this model of the universe, the Sun was the center.

c. Copernicus' heliocentric model can be summarized as follows:

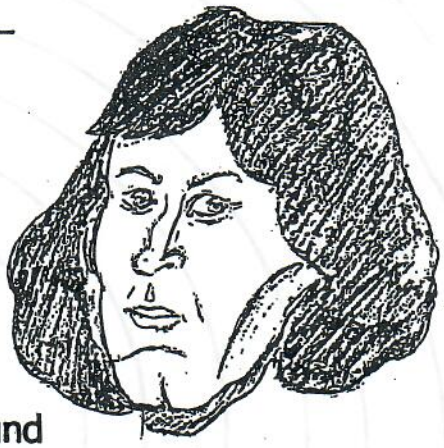
(1) The Sun is located in the center of the system and does NOT move.

(2) The Stars are located on a stationary/unmoving transparent sphere. The sphere is a great distance from the sun.

(3) The planets, including earth, move in circles around the sun.

(4) The moon moves in a circle around earth.

(5) earth rotates on its axis from west toward east each day.



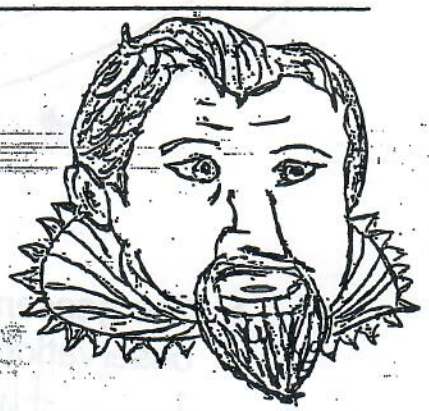
Nicholas Copernicus
1473-1543

d. Copernicus' heliocentric model does NOT explain the apparent cyclic variations in the size of the Sun, and the cyclic variation in the orbital speeds of the planets. This is because in Copernicus' heliocentric model, the planets orbit the sun in perfect circles

3. Heliocentric Model (2nd version)

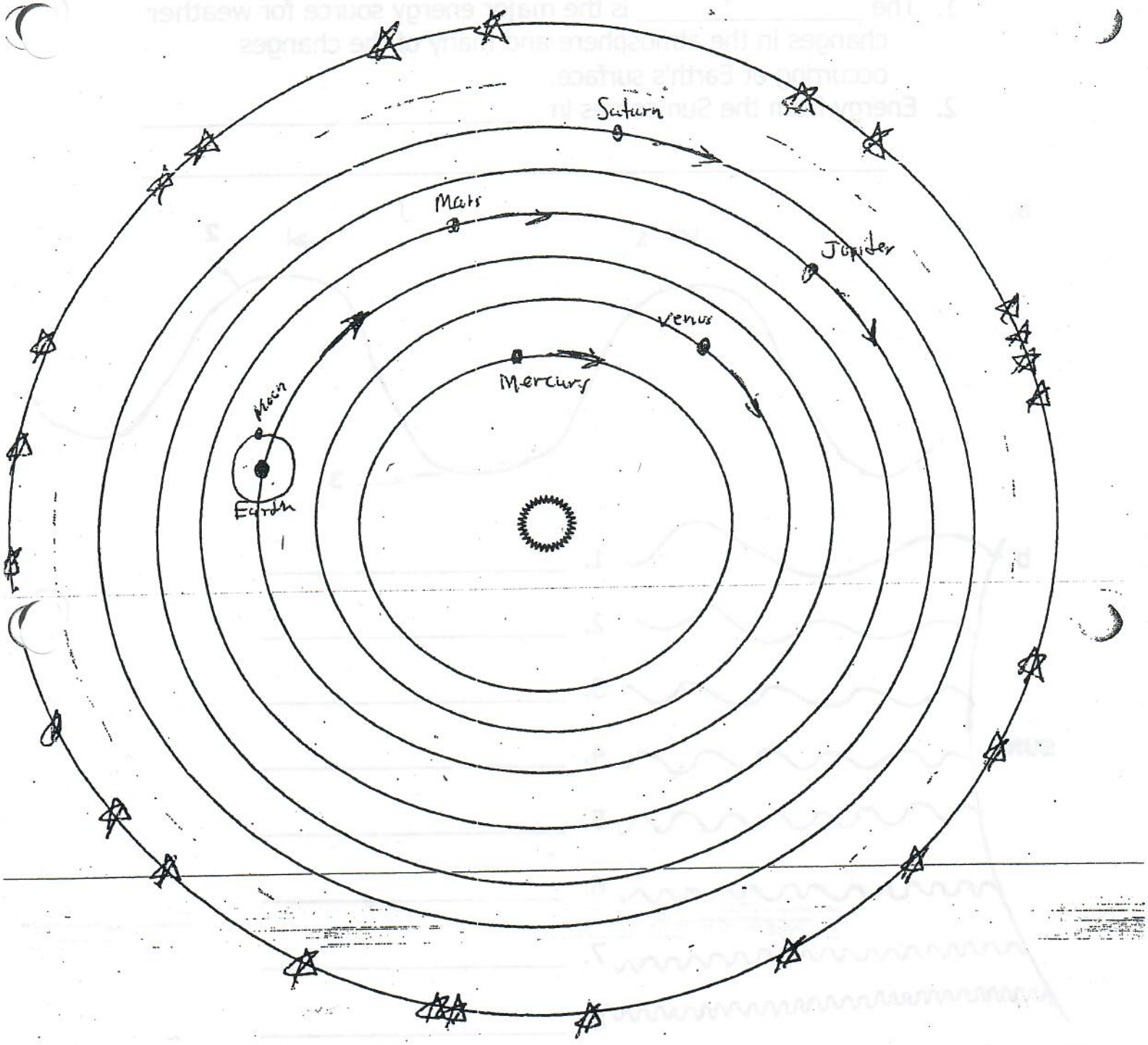
a. In 1609, Johannes Kepler published a book which included his first two "Laws of Planetary Motion" (notes pages 12-15). These laws explain why the apparent size of the sun changed, and why the speed of a planet changes as it orbits the sun.

This is because the orbit of the planets were "elliptical" and not circular



Johannes Kepler

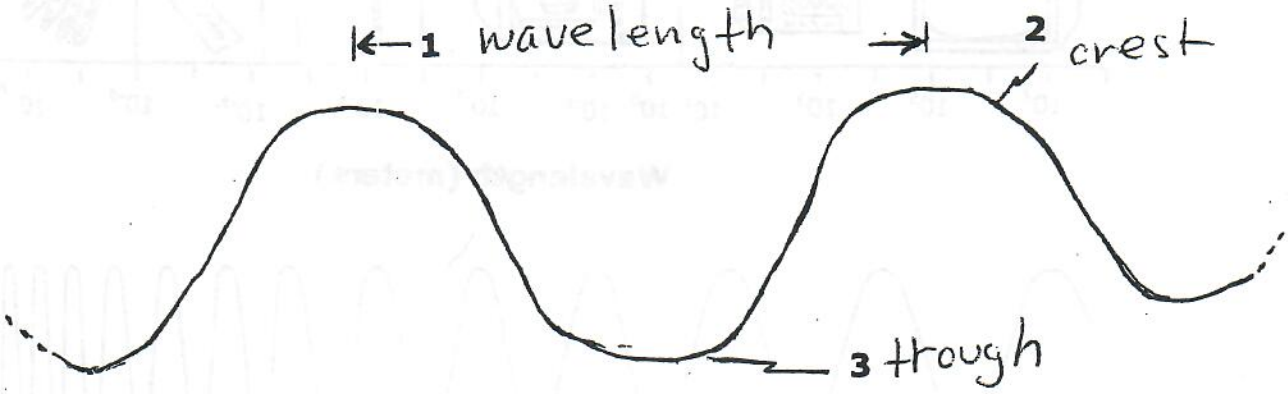
Heliocentric model



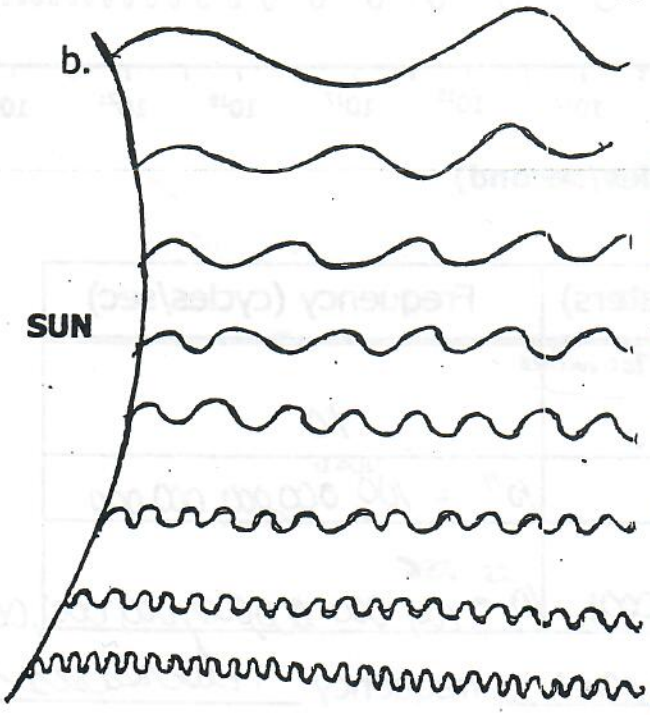
A. Electromagnetic Energy

1. The sun is the major energy source for weather changes in the atmosphere and many of the changes occurring at Earth's surface.
2. Energy from the Sun comes in many different wavelengths

a.

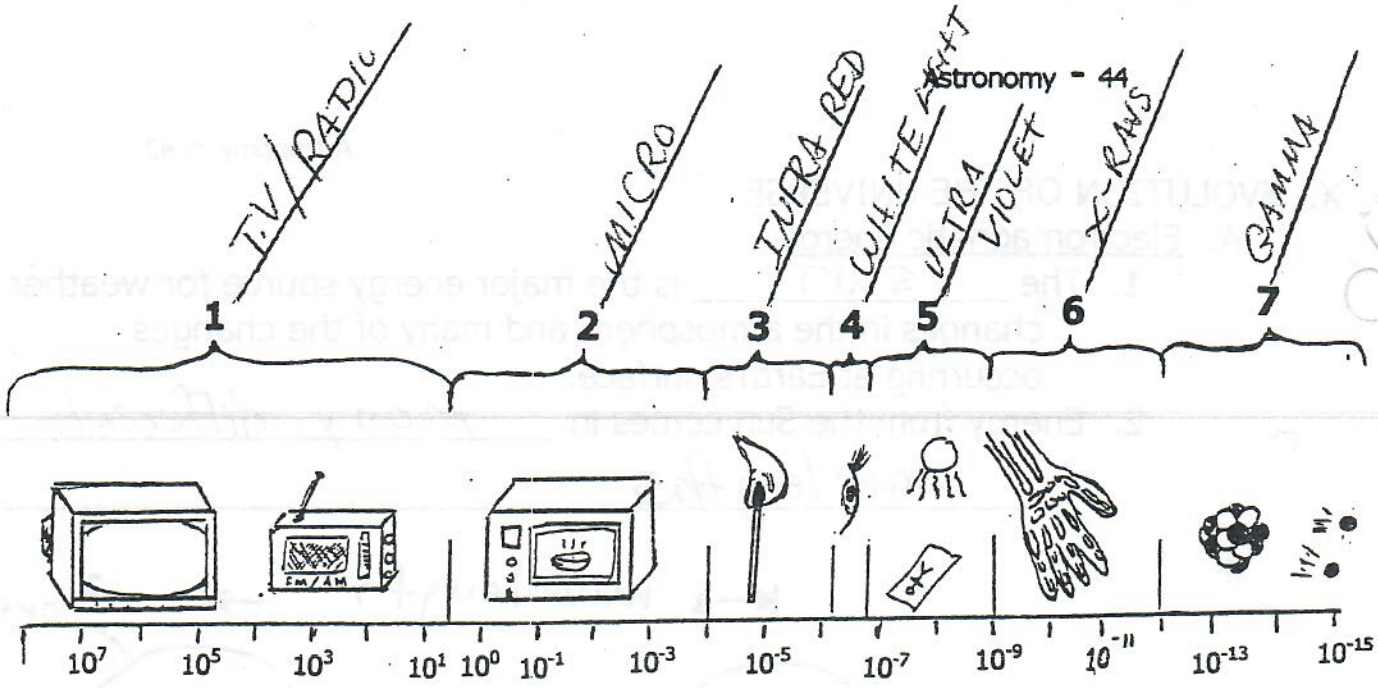


b.

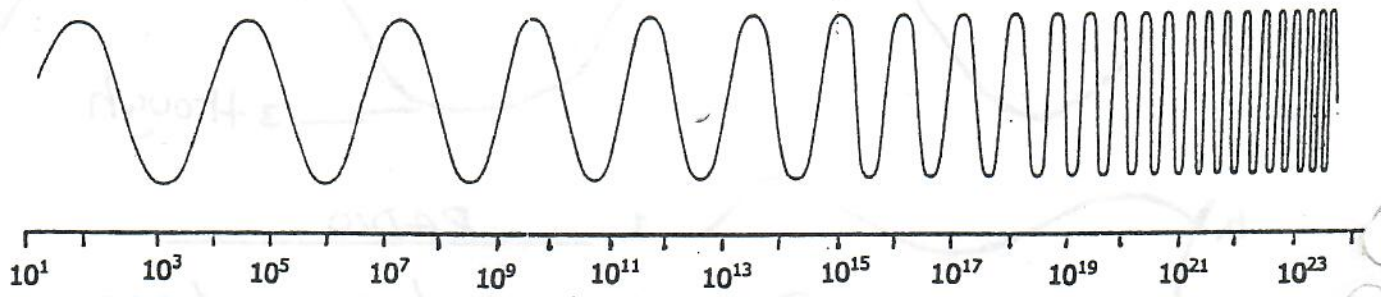


1. RADIO
2. TV / RADAR / MICRO
3. INFRA RED
4. VISIBLE / WHITE LIGHT
5. ULTRA VIOLET
6. X-RAYS
7. GAMMA
8. COSMIC

THE ELECTROMAGNETIC SPECTRUM



Wavelength (meters)



Frequency (cycles/second)

d.

Name of Wave	Wavelength (meters)	Frequency (cycles/sec)
longest RADIO	10^{7} (5,700 miles) 10,000,000	10
Visible Light	10^{-6} .000001	10^{14} = 100 QUAD 000,000,000,000
shortest GAMMA	10^{-15} .000000000000001	10^{23} SEC = 100,000,000,000,000,000,000,000

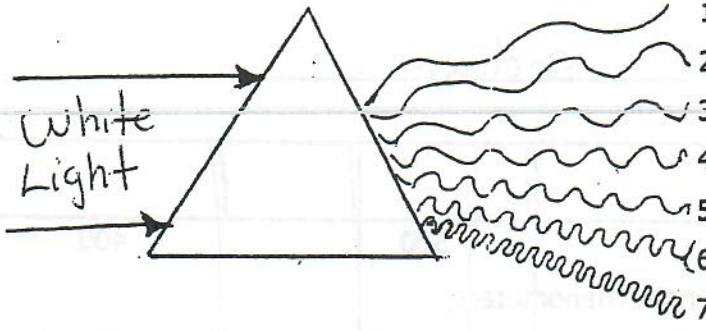
e. As wavelength increases, frequency decreases.

3. All matter gives off electromagnetic energy unless its temperature is at, absolute zero, theoretically the lowest possible temperature (when there is no molecular motion in matter).

B. Kinds of Spectra

1. White/Visible Light

Color



1. Red
2. Orange
3. Yellow
4. Green
5. Blue
6. Indigo
7. Violent

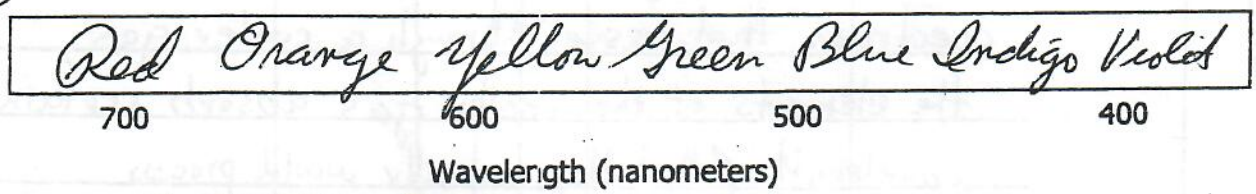
2. Continuous Spectrum

a. unbroken band of colors

b. contains all wavelengths

c. produced by 1. glowing solid (light bulb filament)
2. glowing liquid (molten lava)
3. glowing gas under pressure/compressed (star inter

COLOR



3. Bright Line Spectrum

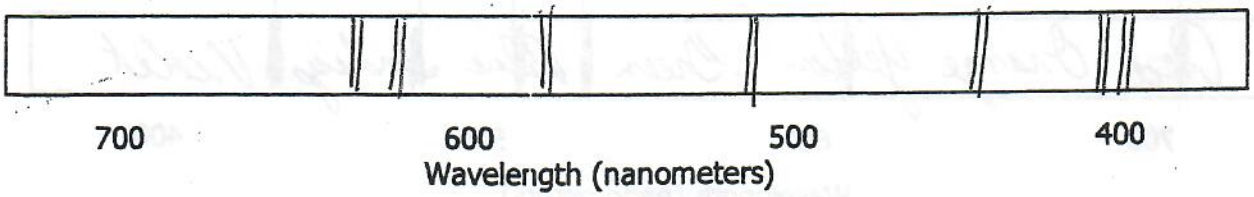
a. different wavelengths which appear as bright lines at different places on the spectral field.

b. each element/atom has its own unique bright line spectra (fingerprint)

c. produced by chemical element in the form of a glowing gas/vapor

color

ex.1

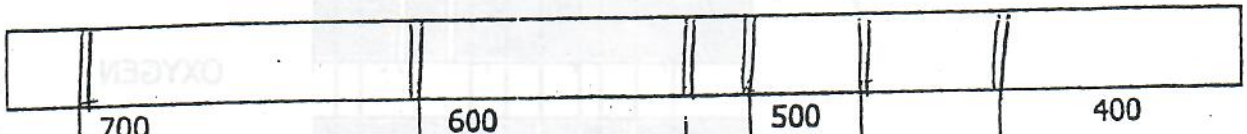


The element mercury

ex.2

The element: Sodium

ex.3

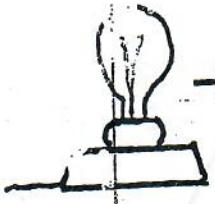


The element: helium

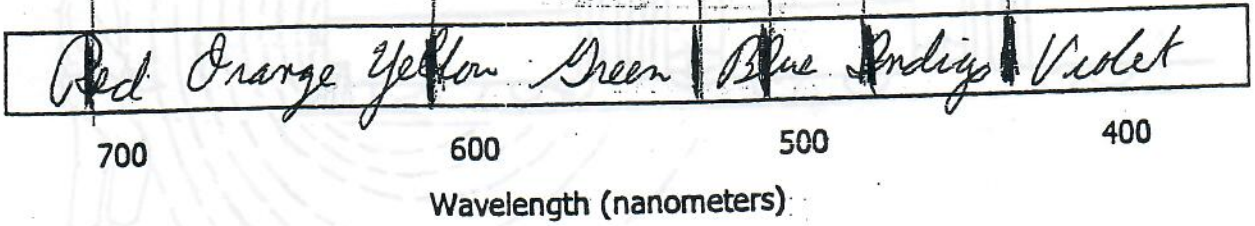
3. Dark Line Absorption Spectrum

a. a continuous spectrum with dark lines — dark lines are where certain wavelengths are absorbed in the same place as bright lines (of an element)

b. produced by light that produces a continuous spectrum that passes through a cooler gas, the elements of the cooler gas absorb certain wavelengths (that they normally would process as bright lines — if heated under pressure)



→ a continuous spectrum → cooler gas of helium → dark line spectrum

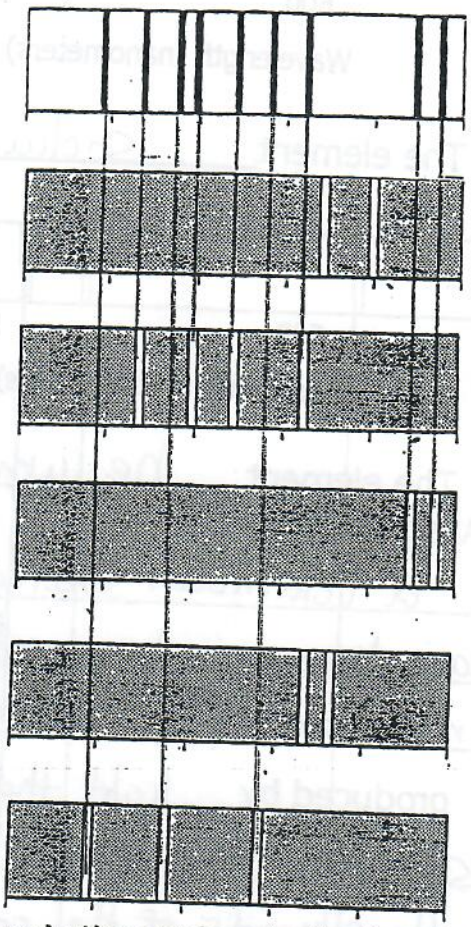


C. Composition of Stars

use ruler

Dark line/Absorption Spectrum of Star Light ⟷

Bright Line Spectrm of Elements as viewed on Earth (in laboratories) ⟷



OXYGEN

IRON

SODIUM

MAGNESIUM

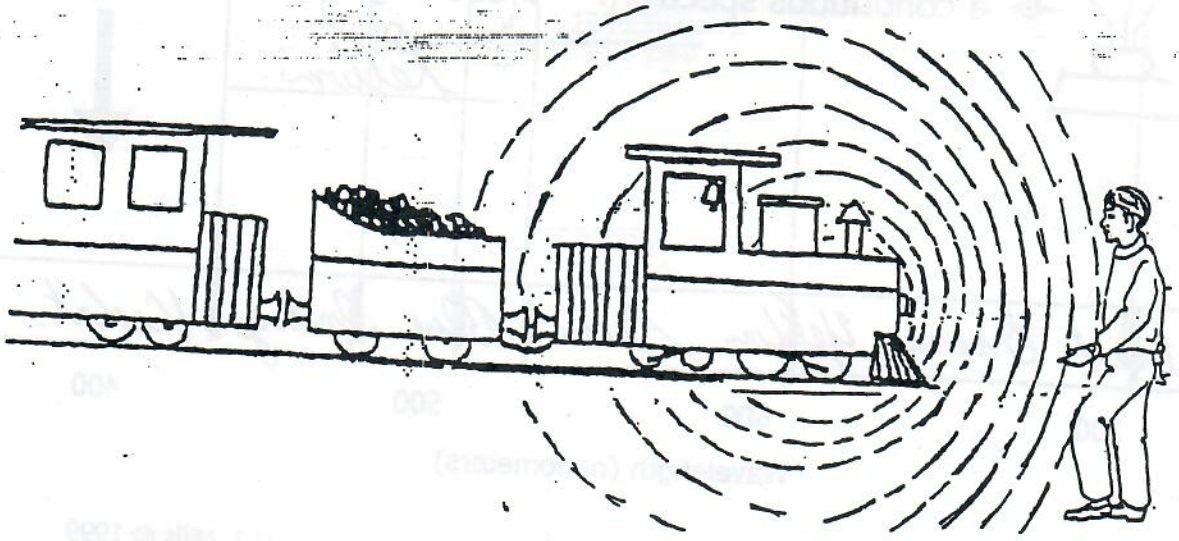
HYDROGEN

What elements (listed above) occur in the star's outer(and cooler) layer?

iron, sodium, hydrogen

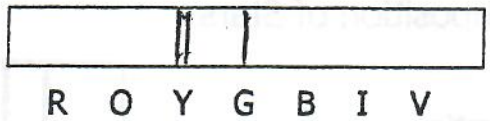
D. The Doppler Effect – apparent change in the wavelength of light (or sound) that occurs when an object is moving toward or away from the observer.

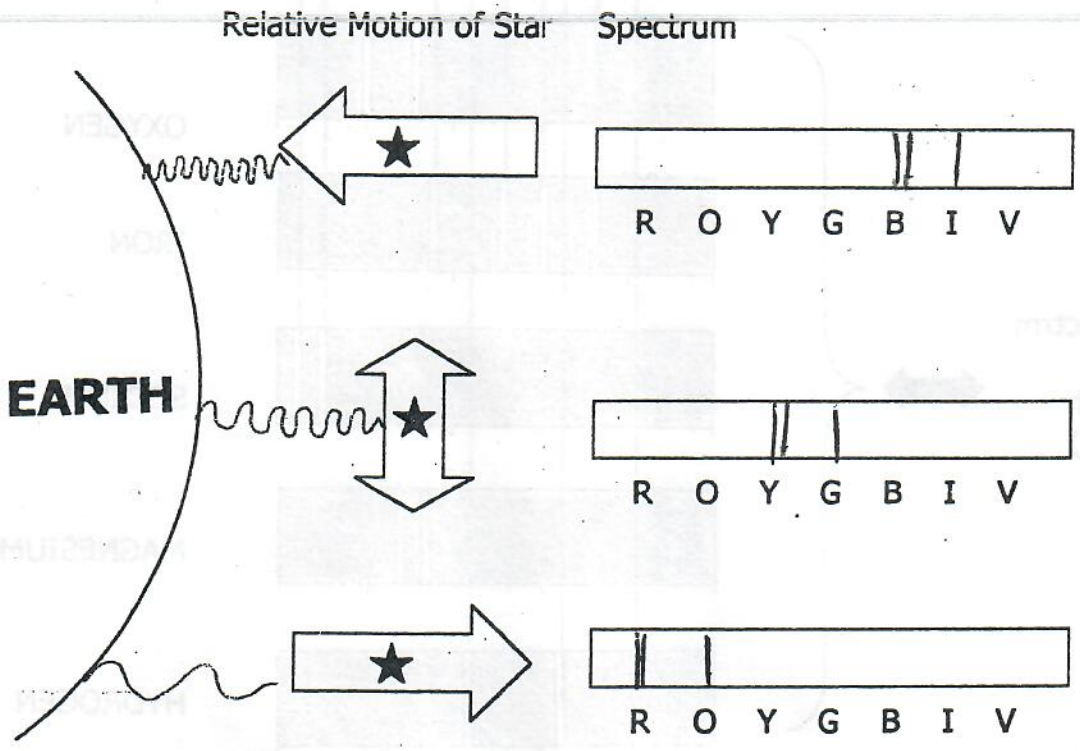
1.



2. Red Shift – Blue Shift Motion

Standard Bright Line Spectrum
Of Element X (Earth Laboratory)





a. In the late 1920's, Edwin Hubble discovered that **ALL** galaxies were "red-shifted" when viewed from Earth.

This meant that all galaxies were moving away from Earth and each other,

and thus, the universe must be expanding!

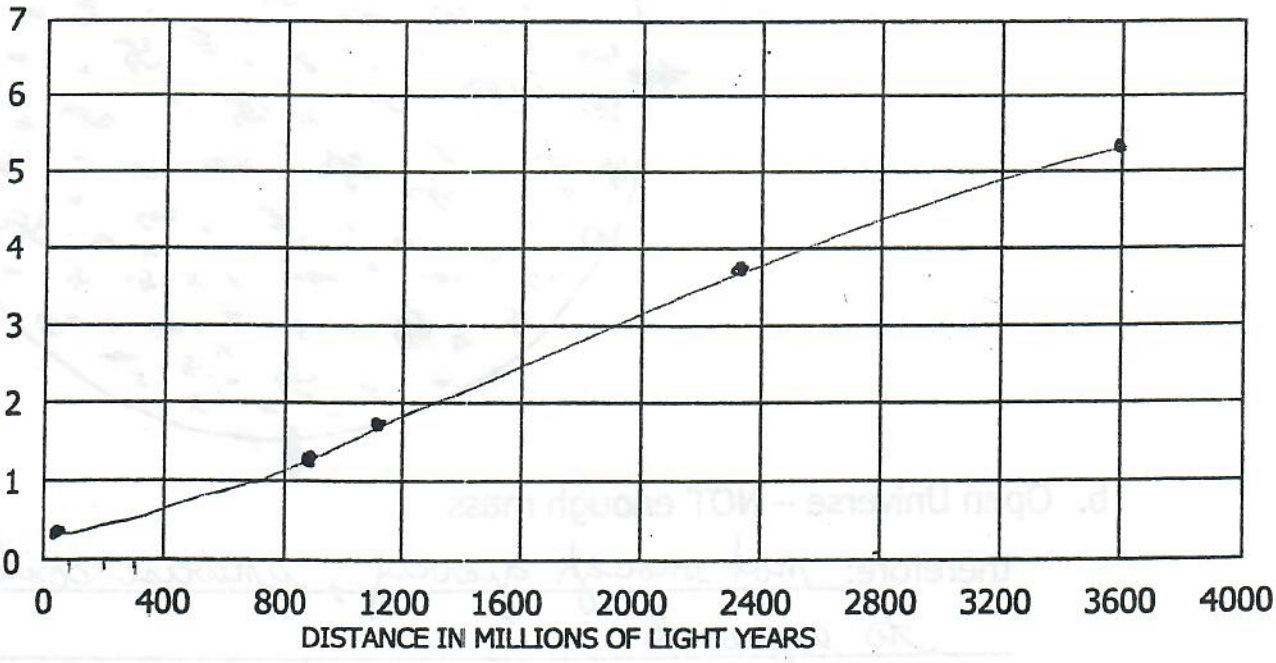
c. An echo of background radiation can still be detected by radio telescopes.

d. The data table below shows the distances of some galaxies from Earth. It also shows the "red shift" of each galaxy and how many units of red shift are exhibited by each galaxy.

1.

GALAXY	DISTANCE (light years)	RED SHIFT (arbitrary units) VIOLET → RED 0 1 2 3 4 5 6
VIRGO	70 000 000	
URSA MAJOR 1	900 000 000	
LEO	1 100 000 000	
BOOTES	2 300 000 000	
HYDRA	3 600 000 000	

2.



3. The amount of "red shift" is a result of the speed at which the galaxy is moving.

4. CONLCUSION: As the distance from Earth increases, the amount(degree) of red shift of a galaxy increases; this indicates that the farther a galaxy, the faster it is moving.

Nuclear Fusion - is the process by which the sun and other stars generate light and heat.