SPASH ASTRONOMY
CHAPTER 1: PREHISTORIC ASTRONOMY
OVERHEAD LECTURE NOTES

1. When did Astronomy begin and what could it have been used for?
Earliest astronomical artifacts date back as far as 30,000 BC possibly. In a hunting society the people who could keep track of time, seasons, and could keep a calendar (figure 1-2) were more successful at providing for their family. Early sky watchers saw the heavens in religious terms. The sky was the home of the gods as they controlled day and night, storms, and the great eclipses. With a 29.5 lunar cycle women could use the moon to keep track of their 27 to 30 day menstrual cycle.

2. What huge change for mankind took place around 10,000 BC and what effect did it have on Astronomy?
Around 10,000 BC the agricultural revolution began. Now cities could begin as migration with the herds was no longer necessary. Great observatories like Stonehenge (Figures 1-10 thru 1-12) were built to keep more accurate calendars. Again the people who could keep track of seasons better made more successful farmers thus providing for their family better.

The following concepts were handed down to us from these early people. Because of light pollution and busy lives many people do not know these fundamental concepts today.

3. All the stars slowly wheel around a single point (in each hemisphere) in the sky due to the Earth's rotation on its axis. These points are the **celestial poles** which can be thought of as the projection of the Earth's axis onto the sky, or the spots targeted by vertical searchlights at the North and South Poles. One can determine their latitude by how many degrees this spot is above the horizon.

4. **Polaris** is the star at the end of the handle of the little dipper and just happens to lie near the north celestial pole and thus is also referred to as the North Star. (Figure 2-10a) Due to the wobble of the earth called **precession** the North Star changes over a period of about 26,000 years.

Note in figure 2-10b, page 45, that Thuban (the alpha star in Draco) was the North Star in 2000 BC.

5. Wherever an observer stands, the point directly overhead is called the **zenith**, and the point exactly opposite that in the sky is the **nadir**. Point to each now.

6. The **meridian** is an imaginary north-south arc from horizon to horizon through the celestial poles and the zenith. Thus the **meridian** is the highest point that each celestial object reaches above the horizon after which it is setting. What time is it when the sun is on the meridian? Hint: Before the sun crosses the meridian the time is **ante-meridian**, or **A.M.**; and after the sun crosses the meridian, it is **post-meridian**, or **P.M.** (Figure 1-3 page 11)

7. The imaginary circle lying 90° from both the north and the south celestial poles is the **celestial equator.** It is the projection of the Earth's equator onto the sky. Just as the North Star is your latitude above the northern horizon, the celestial equator is your latitude above the southern horizon. The celestial equator is zero declination. Some famous stars near the celestial equator include the three stars in Orion's Belt (look at a celestial sphere and find two more stars near the celestial equator).

8. Our division of the circle into 360 units, or degrees, follows a Babylonian practice of about 3,000 years ago. The decimal (10-based) system of counting and writing numbers later replaced the **sexagesimal** (60-based) system in most uses except the expression of angles and time. What terms in time are sexagesimally related? For angles picture a 1° angle. Now since an angle diverges, if you extend the 1° angle to the stars it is much too large of area, so astronomers break a degree into 60 equal parts called a minute of arc (1'). A minute of arc is also to large so the further broke a minute of arc into 60 equal pieces called a second of arc (1"). So how many seconds of arc are in 1 degree?

9. The apparent path of the Sun among the stars is a circle extending all the way around the sky and is called the **ecliptic**. We now know that the ecliptic is the same as the plane of Earth's orbit around the Sun. Where the ecliptic intersects the celestial equator one finds the first days of spring and

fall and the sun is highest or lowest in the sky on the ecliptic for the first days of summer and winter. (Figure 1-5 page 12)

10. Ancient observers found that seven celestial objects were not fixed in the sky like the stars were. Can you name seven visible objects that change what constellations that they are in over time? This is why we have seven days in a week instead of six or eight! Saturday and Sunday are the easy ones, but can you tell me where the names of the other days of the week came from? {Monday (moon's day), Tuesday (in Latin Martis day of Mars), Wednesday (in Latin Mercuri dies for Mercury), Thursday (or Thor day after Jupiter the God of Thunder), and Friday (Freo goddess identified with Venus). These became known in the Western world as **planets**, from the Greek word **"wanderers"**.

11. Ancient observers noted that the planets never stray out of a zone about 18° wide centered on the ecliptic. Many star patterns, or constellations, along this zone were said to resemble animals, so the zone came to be called the **zodiac** (after Greek for "animals" – the same root as zoo). There used to be twelve constellations in the zodiac but now due to precession the sun travels thru thirteen as follows:

Astronomical Constellations of the Ecliptic

Constellation	Dates		# of d
Sagittarius	Dec 18	Jan 18	32
Capricornus	Jan 19	Feb 15	28
Aquarius	Feb 16	Mar 11	24
Pisces	Mar 12	Apr 18	38
Aries	Apr 19	May 13	25
Taurus	May 14	Jun 19	37
Gemini	Jun 20	Jul 20	31
Cancer	Jul 21	Aug 9	20
Leo	Aug 10	Sep 15	37
Virgo	Sep 16	Oct 30	45
Libra	Oct 31	Nov 22	23
Scorpius	Nov 23	Nov 29	7
Ophiuchus	Nov 30	Dec 17	18

Dates may fluctuate plus or minus a day from year to year.

And the planets travel thru all 24 of the following (instead of just 12): Astronomical Constellations of the Zodiac now are

Aquarius	Cetus	Libra	Scorpius
Aries	Corvus	Ophiuchus	Scutum
Auriga	Crater	Orion	Serpens
Cancer	Gemini	Pegasus	Sextans
Canis Minor	Hydra	Pisces	Taurus
Capricornus	**Leo**	**Sagittarius**	**Virgo**

12. The **heliacal rising** of a star occurs on the first day each year when the star can be seen just before dawn. (Heliacal means "near the sun", from the Greek helios, "sun") One or more days earlier it is to bright to notice the star because of dawn. Similarly, **heliacal setting** occurs on the last day each year when the star can be seen at dusk. On the next day, by the time darkness falls, the star has already set. Since the heliacal rising or setting occurs on the same date every year it could be used as a calendar to tell the date with an accuracy of a day or two. The ancient Egyptian calendar began with the heliacal rising of Sirius, which marked the beginning of the Nile's annual flooding. Can you find the dates of the helical risings and settings of Sirius, Vega, Polaris, and Acrux (in the southern cross) for Stevens Point? (Figure 1-6)

13. The **north circumpolar zone** contains the stars that never set and for Stevens Point would include the stars in the constellations of Ursa Major and Minor, Cassiopeia, Draco, and Cephus. The **equatorial zone** contains the stars that rise and set which would be all the other constellations besides the five mentioned above that we see throughout the year. And the **south circumpolar zone** contains the stars that never rise in Stevens Point. If you lived on the equator there would only be one zone, and at either of the poles only two zones, can you name them? (Answers: at the equator only the equatorial zone and at the poles only the circumpolar zones).

14.. What causes our seasons and why are equinoxes and solstices important to seasons?
(Figure 1-8 page 15)
The tilt of the Earth on its axis causes our seasons. If you can imagine Earth's orbit being a circle around the sun and the celestial poles a stick through the axis of Earths rotation, then the stick would make a 23.5° angle with the circle.
On the equinox's the entire planet has 12 hours of light and 12 hours of darkness (thus equal) whereas only the equator has this phenomenon the rest of the year. The spring or **vernal equinox** (about March 21) the sun crosses the celestial equator moving north, and rises due east, The **summer solstice** (about June 22) the Sun reaches the point farthest north of the celestial equator. So you can guess what **the autumn equinox** (about Sept. 23) and the **winter solstice** (about Dec. 22) are.

15. **Never** confuse **Astronomy** with **Astrology?**
Astrologist believes that the stars and planets control or at least influence human affairs. An occupational hazard of being an astronomer is to be introduced at parties as an astrologer. At the time Astrology started the sun, planets and moon traveled through the 12 original constellations of the zodiac, now the sun travels through 13 constellations (note charts on page 2) and the planets and moon through 24 constellations. The only two good things I can say about Astrology is that it's there for a good laugh on the comic page and that **Astrologers would pay Astronomers** in the early days for knowing where the planets, moon, and sun would be among the constellations on any given day. Thus Astronomy is the study of all matter and energy in the universe, emphasizing the concentration of this matter and energy in evolving bodies such as planets, stars, and galaxies. It recognizes that we observers -humanity- are part of the universe, and that our home, Earth, is only one of the many places in the universe, but also the special point from which our voyage of exploration has started.

16. A **solar eclipse** is when the moon passes between the earth and the sun and blocks out the sun or eclipses it. The moon passes between the earth and the sun every 29.5 days but the orbit of the moon makes a 5° angle with Earths orbit. The orbit of the moon intersects the plane of Earth's orbit at two points. If the moon just happens to be at new moon during the time it passes the point of this intersection between the sun and the earth we get a

solar eclipse. The **saros cycle** or 18 years 11 days is the time between a similar sequence of eclipses discovered over 2,000 years ago. A **lunar eclipse** is when the earth passes between the moon and the sun so that the shadow of the earth falls on the moon. Now the moon has to be a the other intersection point at full moon for this to occur. Since the Earth is larger than the moon it cast a larger shadow so lunar eclipses occur more often and cover a much larger region of the Earth. On the average a given location may witness a lunar eclipse nearly every year and a partial solar eclipse nearly every other year, but a total solar eclipse only about once every four hundred years. (Table 1-1 page 30 shows total solar eclipses until 2025).
(http://umbra.nascom.nasa.gov/eclipse/images/eclipse_images.html)

17. How can Astronomy be used to pinpoint the crucifixion?

Peter, reported in Acts, which refers to a blood-red moon. Calculating the dates of lunar eclipses, they find that a partially eclipsed Moon rose over Jerusalem on the night of Friday, April 3, A.D. 33, which they conclude was the date of the crucifixion. Many similar observances have been found in ancient books that have helped determine when they occurred.

18. As memory aids for learning and locating stars, early observers named groups of stars for their resemblance to familiar animals, objects, and mythical characters. These groups are **constellations**. People in different cultures saw different patterns, often derived from their mythologies. Now the entire sky is divided up officially into 88 of these regions or constellations (same as the number of keys on a piano keyboard). All objects that move through the sky move through the backdrop of these regions thus it is important to learn these regions to describe where an object is in the nighttime sky. Oh look by the tail of the big bear, or the satellite appeared in Leo, passed thru Cancer, and disappeared in Canis Minor.