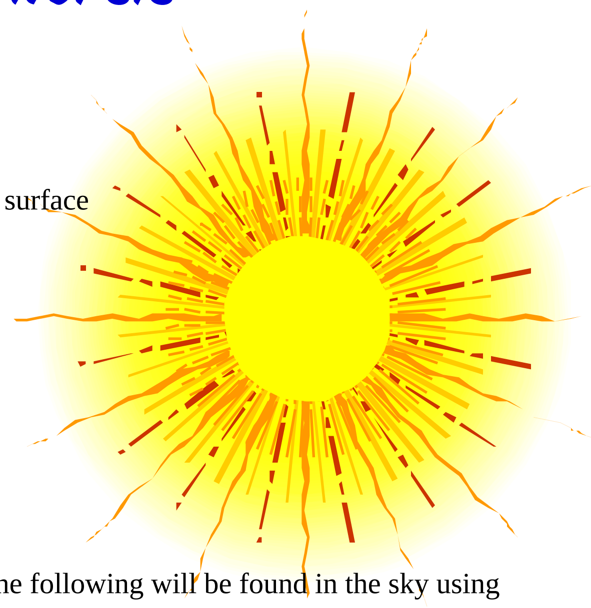
STARS!
Teacher's Guide

This Teacher's Guide is designed to help you better prepare your students for their upcoming visit to the Northern Stars Planetarium. The program you have chosen is called Stars and that's precisely what it's about. Please remember that this program is given to many different grade levels; therefore, some of the vocabulary and activities may be either too old or too young for your particular class. Please use only what you feel is appropriate. Rest assured that the planetarium presentation will be properly adapted to the level of your class.

SHOW SYNOPSIS



I. Examination of the Sun, our nearest star.

1. The core and how it works
2. How the energy gets from the core to the surface
3. The surface of the Sun
   a. The photosphere
   b. The chromosphere
   c. The corona
4. The Active Sun
   a. Sunspots
   b. Prominences
   c. Flares

II. The stars outside at night. (Examples of all the following will be found in the sky using constellations as our guide)

1. Binary and multiple stars
   a. Variable star activity
2. Stellar life cycles
   a. Birth from a nebula
   b. Expanding star
   c. Death of average stars like the Sun
3. Supernovae (the death of big stars!)
   a. Neutron Stars and pulsars
   b. Black Holes

WARNING! NEVER LOOK DIRECTLY AT THE SUN. THIS MAY CAUSE BLINDNESS!!

VOCABULARY

Binary Star: Two stars that revolve around each other. Half of all the stars we see in the night sky are actually double or multiple star systems, but their distance makes them look like one star to the unaided eye.

Black Holes: Black Holes are what is left of super-massive stars at least ten times larger than the Sun after the star has exploded in a supernova. In this case, the density is so high and gravity has become so great that the remains of the star's core (which is still several times greater than the mass of the Sun) has shrunk to the point where it effectively has no volume. The gravity is so strong that not even light can escape.

Chromosphere: The first layer of a star's atmosphere above the photosphere. It is slightly hotter and is comprised of jets of gas over 6,000 miles high coming out of the photosphere.

Corona: The outermost part of the Sun's atmosphere and hotter than the photosphere or the chromosphere. It expands away into space and becomes the "Solar Wind", which extends well out beyond Uranus.

Density: The mass of a substance per unit of volume. An object is said to be of a high density if the mass is great while the volume is small. Lead has a high density. An object is said to be of a low density if the mass is low while the volume is great. Stryofoam has a low density.

Fission Reaction: This does not take place in stars – this is what takes place in nuclear power plants. This is where heavy elements like Uranium or Plutonium are broken down into lighter elements. This type of reaction also produces energy, but not as much as is produced by fusion reactions.

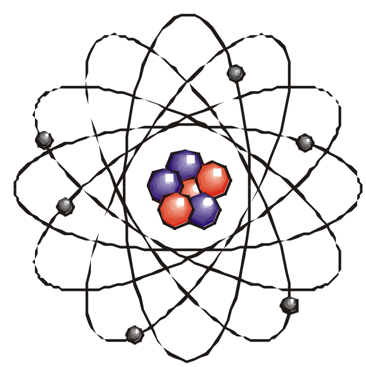
Fusion Reaction: This is what takes place in the center of stars. It is what happens when the pressures become so great that light atoms (like hydrogen) are forced to fuse together and thus create heavier elements. This reaction also produces great amounts of energy.

Light Year: A light year is the distance that a beam of light will travel in one year's time. Light travels at 186,000 miles per second. Astronomers use this unit to measure great distances in space. It equals about 6 trillion miles! For example, the closest star to the Sun is Alpha Centauri, which is 4.3 light years away, or 25,278,000,000,000 miles!

Mass: Mass is the amount of material that an object is made of.

Nebula: A huge cloud of hydrogen gas floating in space. Usually many light years across in size. These hydrogen nebulae are slowly contracting and forming into new stars.

Neutron: One of the three basic parts of an atom. The three parts are: 1. electrons, which have a negative charge and orbit the nucleus; 2. protons, which have a positive charge and are part of the nucleus; 3. neutrons, which have no charge and are part of the nucleus.



An Atom, Neutrons (blue)
Protons (Red) Electrons (Gray)

(VOCABULARY CONTINUED)

Neutron Star: This is what remains of the original star after a supernova takes place. It is much more massive than a white dwarf and its diameter might be less than 10 miles. It is so compact that its atoms have actually been crushed to the point that only neutrons exist.

Photosphere: The visible surface of the Sun or any star.

Planetary Nebula: A circular nebula, composed of many types of gases, that is expanding into space. Planetary Nebula are the result of the death of an average star (like the Sun). The nebulosity you see is the outer layers of the star that have been blown out into space. They actually have no relationship to planets; they are called "planetary" because of their appearance only, which led early astronomers to mistake them for undiscovered planets.

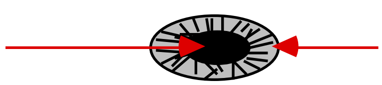
Prominence: On stars, huge looping, glowing arcs of gas that lie suspended between magnetic lines of force between sunspots. They can last up to two weeks and can be 70,000 miles long, reaching into the chromosphere and the corona.

Pulsar: A rapidly spinning neutron star with a magnetic field. Natural radio waves extend out of the magnetic pole areas, providing pulsating radio beacons as the neutron star rotates. Pulsars can rotate with periods between once every few seconds to speeds of hundreds of rotations per second.

Solar Flares: While physically much smaller than prominences, flares are much more powerful and give off tremendous amounts of energy and radiation into space. Usually they last from 20 minutes to several hours. They produce the energy that causes aurora on Earth.

Sun: The nearest star to Earth. It is about 1.2 million times larger in volume than Earth, but is only average in size when compared to other stars. It has a surface temperature of 12,000 degrees Fahrenheit. The Sun is a yellow star that burns hydrogen in its core.

Sunspot: A magnetic disturbance in the Sun's photosphere. They usually occur in pairs – one positively charged and one negatively charged. They appear dark in the photosphere because they are cooler (average temperature 8,500 degrees Fahrenheit) than the surrounding photosphere. Sunspots are part of an eleven year cycle, peaking in numbers every 11 years, then diminishing midway through the cycle. Sunspots have two structural parts as illustrated:

Umbra (center)  Penumbra

Supernova: The violent death of a very massive star (8 or more times larger than the Sun). The star becomes internally unstable and violently explodes, becoming perhaps 1 billion times brighter than before. It releases as much energy in one second as the Sun will in 100 years. Gradually with time, the supernova explosion will diminish in brightness.

Supernova Remnant: This is what we call the rapidly expanding cloud of various gases that is released from a supernova explosion. There are many supernova remnants visible with telescopes in the night sky.

Volume: The amount of space that an object takes up.

White Dwarf: The dead remains of an average sized star such as the Sun after the outer layers have been expelled into space to form a planetary nebula. White dwarfs are extremely dense – they have nearly the mass of the Sun while only the volume of Earth. White dwarfs are caused when fusion reactions in the core decline or stop then gravity collapses the star.

COMPARATIVE STAR SIZES ACTIVITY

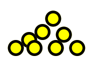
Materials needed:

- 1 basketball
- 1 pea
- 1 ping pong ball
- 1 mustard seed
- 1 small (yes, as small as possible!) grain of sand

Comparison #1: Earth to Sun. Tell your students that the basketball represents the Sun. Have them guess which object would properly represent Earth. (The mustard seed is correct.)

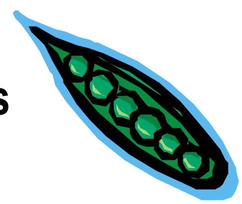
Comparison #2: Sun to other stars. Discuss the various sizes of stars listed on the "Comparative Star Sizes Chart" found on page 5 in this teachers guide. At this scale:

Sun = Pea
Hot Blue Star (like Vega, Sirius or Spica) = Ping Pong Ball
Red Super-Giant (like Betelgeuse or Antares) = Basketball
White Dwarf (as fond in the Ring or Dumbell Nebulae) = Grain of Sand
Neutron Stars and Black Holes would not be visible at this scale.



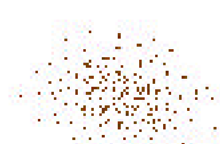
Mustard Seeds

Peas



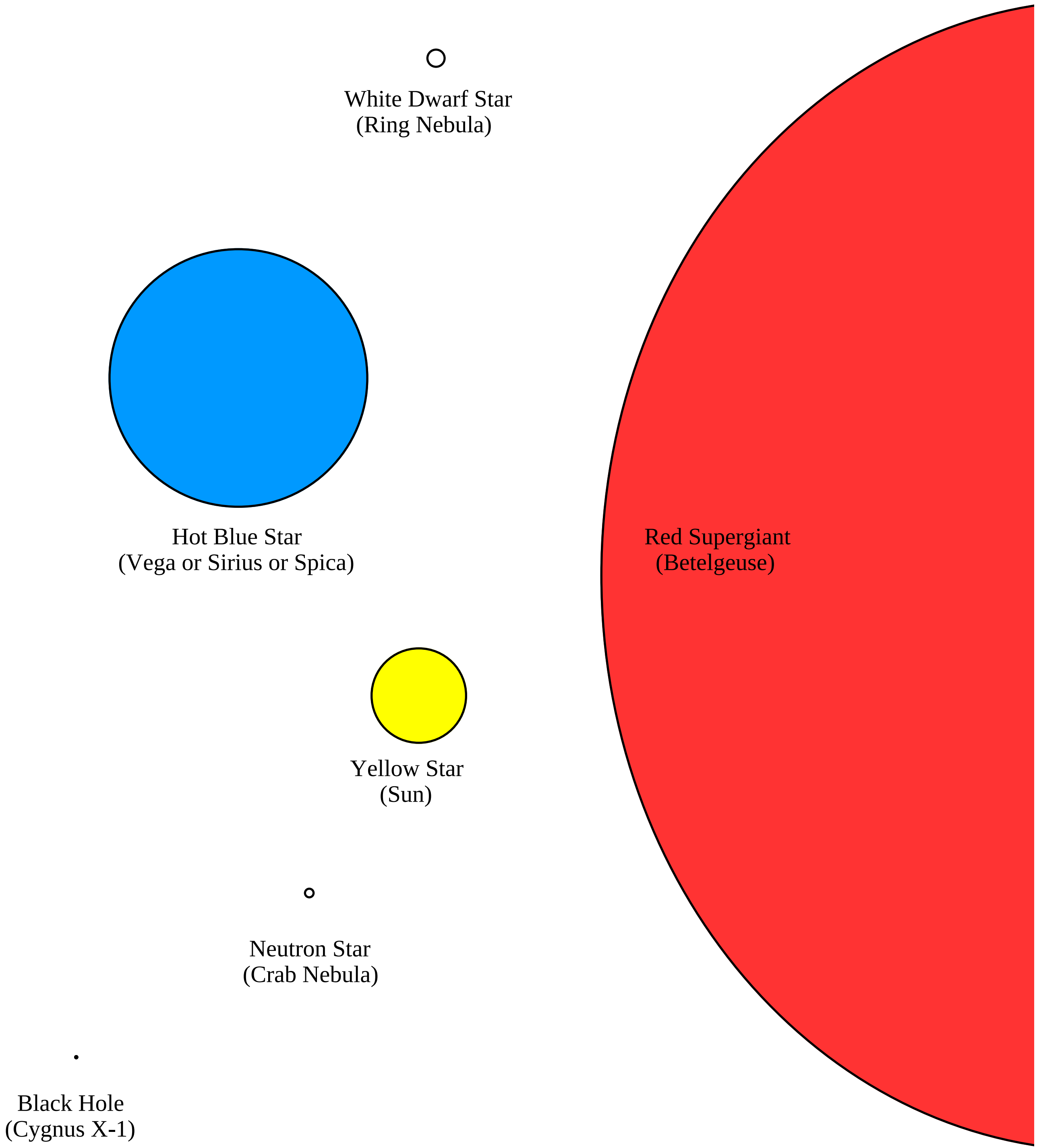
Ping Pong Ball

Basketball



Sand

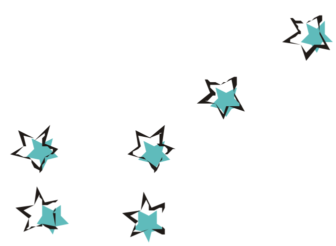
COMPARATIVE STAR SIZES



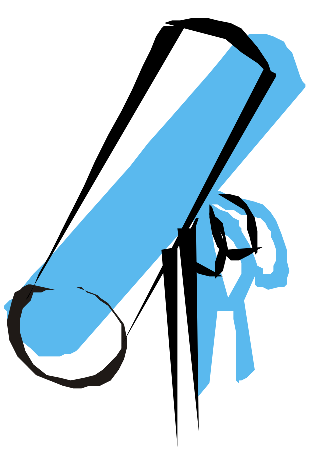
WORD SEARCH

Try to find the words listed on the bottom of the page within the following puzzle. Words may be written horizontally, vertically, or diagonally. Good luck!

S	**E**	**B**	**C**	**R**	**E**	**A**	**C**	**T**	**I**	**O**	**N**	**P**	**B**
R	**U**	**O**	**O**	**X**	**F**	**L**	**D**	**B**	**B**	**G**	**L**	**H**	**I**
E	**S**	**P**	**R**	**Y**	**T**	**L**	**M**	**F**	**U**	**S**	**I**	**O**	**N**
V	**J**	**U**	**E**	**B**	**S**	**P**	**A**	**H**	**W**	**T**	**A**	**T**	**A**
O	**I**	**L**	**N**	**R**	**I**	**U**	**F**	**R**	**M**	**G**	**Z**	**O**	**R**
L	**K**	**S**	**P**	**E**	**N**	**T**	**N**	**H**	**E**	**A**	**T**	**S**	**Y**
V	**W**	**A**	**H**	**V**	**J**	**O**	**D**	**S**	**R**	**T**	**S**	**P**	**H**
E	**H**	**R**	**D**	**C**	**I**	**L**	**V**	**T**	**P**	**V**	**K**	**H**	**Y**
F	**I**	**S**	**S**	**I**	**O**	**N**	**X**	**A**	**J**	**O**	**A**	**E**	**D**
C	**T**	**N**	**F**	**Q**	**U**	**R**	**Y**	**R**	**U**	**L**	**T**	**R**	**R**
L	**E**	**E**	**E**	**U**	**U**	**B**	**O**	**R**	**D**	**I**	**O**	**E**	**O**
U	**D**	**U**	**R**	**B**	**D**	**T**	**F**	**N**	**O**	**G**	**M**	**T**	**G**
S	**W**	**T**	**A**	**K**	**U**	**B**	**E**	**N**	**A**	**H**	**P**	**R**	**E**
T	**A**	**R**	**Z**	**H**	**E**	**L**	**I**	**U**	**M**	**T**	**O**	**F**	**N**
E	**R**	**O**	**T**	**A**	**T**	**E**	**A**	**G**	**A**	**L**	**A**	**X**	**Y**
R	**F**	**N**	**B**	**L**	**A**	**C**	**K**	**H**	**O**	**L**	**E**	**O**	**N**



ATOM
BINARY
BLACK HOLE
CLUSTER
CORE
CORONA
FISSION
FLARE
FUSION
GALAXY
HEAT
HELIUM
HYDROGEN



LIGHT
NEBULA
NEUTRON
ORBIT
PHOTOSPHERE
PULSAR
REACTION
REVOLVE
ROTATE
STAR
SUN
SUNSPOT
SUPERNOVA
WHITE DWARF

STUDY QUESTIONS

1. What is a star? (A large ball of mostly hydrogen gas that has sufficient internal pressures to cause nuclear fusion within its core.)

2. Do stars have solid surfaces? (No)

3. Are all stars white? (No. Stars actually are many different colors: red, orange, yellow, blue, violet and white.)

4. Why can't we generally see the different colors of the stars? (Because the part of your eye that you use to see faint objects, such as stars, is color-blind.)

5. What do the different colors of stars tell us about stars? (The temperature of the stars. Red stars are cool [6,000 – 8,000 degrees Fahrenheit], yellow stars are hotter [12,000 – 14,000 degrees Fahrenheit] and Blue & White stars are the hottest [16,000 – 21,000 degrees Fahrenheit].)

6. Will the Sun last forever? (No. It is about 8 billion years old and has enough hydrogen to burn for about another 8 billion years.)

7. Will the Sun become a black hole? (No, because it is not big enough. For a star to become a black hole, it has to start out at least 10 times bigger than the Sun. When the Sun dies, there will be a mild explosion and its outer layers will expand into space to form a planetary nebula, while the remaining core will become a white dwarf.)

8. How often do we see supernovae? (While it is fairly common to see supernova in other galaxies, within our own Milky Way, it is fairly rare. In the past thousand years, only 4 have been seen in the Milky Way and they all pre-date the telescope. One was in 1006, the second was in 1054 and it produced the now famous 'Crab Nebula' and supernova remnant. The third supernova in our galaxy is called 'Tycho's Star' of 1572, and last was 'Kepler's Star' of 1604. However, a bright supernova was seen in 1987 in the Large Magellanic Cloud – an irregular galaxy visible in the southern hemisphere. It was called 'Shelton's Supernova' and was clearly visible to the unaided eye.)

9. Why do stars twinkle? (Stars don't really twinkle. The twinkling effect is caused by the atmosphere that we are looking through.)

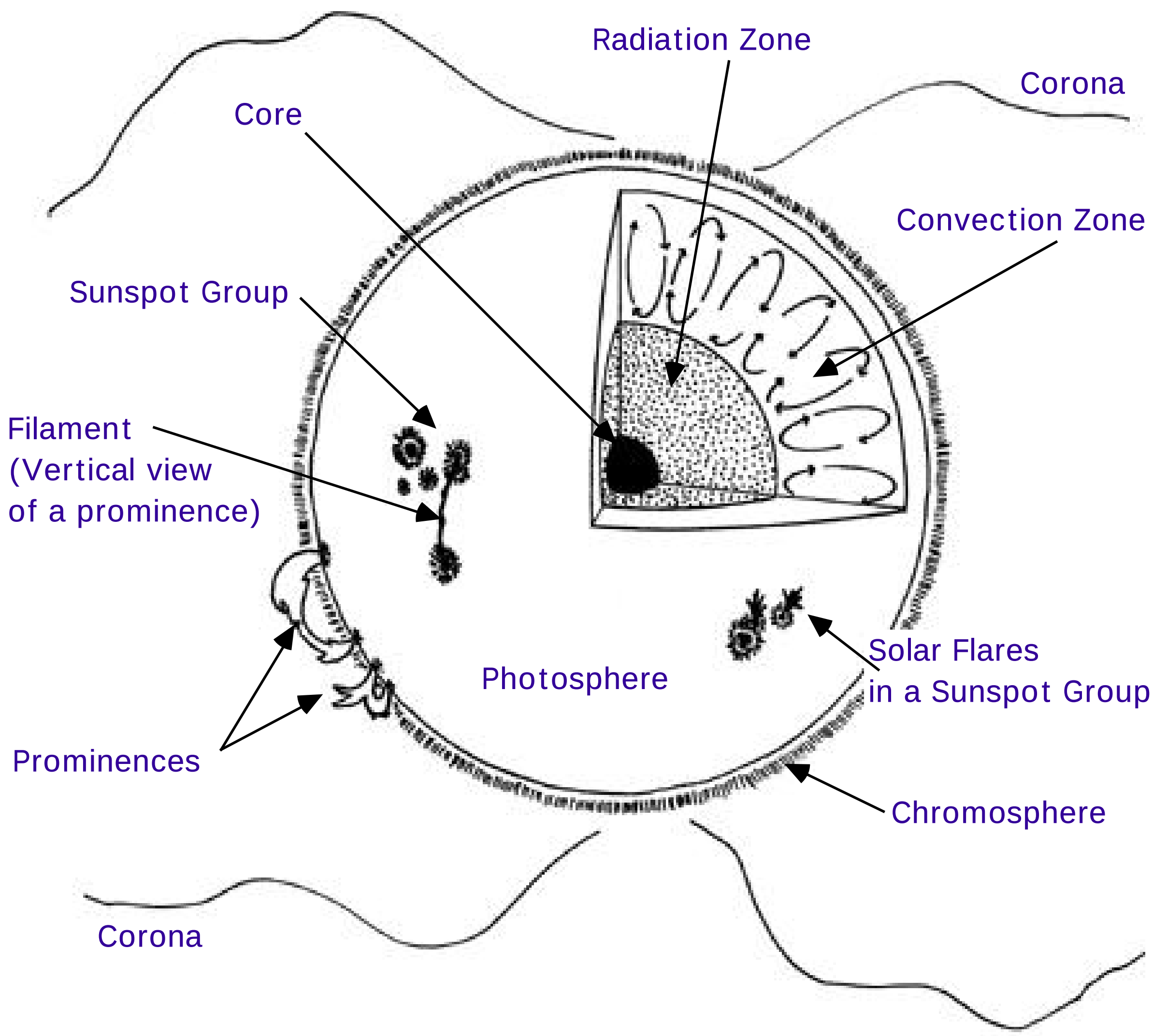
10. What is the nearest star to Earth? (The Sun! The second closest star is Alpha Centauri, which is 4.3 light years away. However, Alpha Centauri is actually a triple star system – the closest of the three stars is called Proxima Centauri.)

TRUE OR FALSE

1. Half of all the stars we see in the night sky are binaries. (T)
2. All the stars we see in the night sky are part of the Milky Way. (T)
3. Sunspots are hot areas on the Sun's surface. (F)
4. Astronomers have discovered a ring of material around the star Vega that may be a solar system in formation. (T)
5. The Sun is composed primarily of helium. (F – it's hydrogen)
6. While the Sun takes 26 days to rotate once, the star Altair rotates once every 6 hours. (T)
7. The Sun spins or rotates faster at the equator than at the poles. (T)

THE SUN

COLOR THE PHOTOSPHERE YELLOW, THE RADIATION ZONE RED, THE CONVECTION ZONE ORANGE. THE CHROMOSPHERE BLUE, AND THE CORONA, PURPLE.



Life Cycles of the Stars

Distribute colored balloons as described below, make a spitball of paper for a core and put inside.

Step #	0.4 Solar Mass Red Star	1 Solar Mass Yellow Star The Sun	3 Solar Mass White Star	9 Solar Mass Blue Star
Beginning	Blow up Star to about 3"	Blow up Star to about 3"	Blow up Star to about 3"	Blow up Star to about 3"
5 Million Years	Wait. Your Star is slowly Burning	Wait.	Wait.	Blow up Star more. It's growing a burning fast.
10 Million Years	Wait.	Wait.	Blow up a little more.	Blow up as fast as you can. Then pop balloon with a pin! Supernova!
500 Million Years	Wait.	Wait. Watch as planets form.	Slowly blow up a little. Star turns yellow/orange. Star is cooling.	Star has Exploded! Throw supernova remnants about the room. Core is a Black Hole.
1 Billion Years	Wait.	Blow up a little.	Blow up as fast as you can. Then pop balloon with a pin! Supernova!	
8 Billion Years	Wait.	Blow up more. Color sun red. Sun is now a red Super Giant.	Star has Exploded! Throw supernova remnants about. Core is a neutron star.	
10 Billion Years	Wait.	Cut Balloon into pieces, a planetary nebula. Place them surrounding core. Core is a white dwarf.		
50 Billion Years	Blow up a little.	Move pieces of planetary nebula a little further away.		
500 Billion Years	Let air out. Star has just slowly shrunk and died. Color core black.	Nebula is gone. Color white dwarf black. It becomes a black dwarf.		

Useful Astronomy Web Sites:

Northern Stars Planetarium: http://www.northern-stars.com

Hubble Space Telescope: http://hubblesite.org/

Astronomy Magazine: http://www.kalmbach.com/Astro/Astronomy.html

Astronomical Society of the Pacific: http://maxwell.sfsu.edu/asp/asp.html

Genesis Mission to Sample the Sun: http://genesismission.jpl.nasa.gov/

SOHO: http://sohowww.nascom.nasa.gov/

Ulysses Solar Probe: http://ulysses.jpl.nasa.gov/

Extra Solar Planets: http://www.obspm.fr/departement/darc/planets/encycl.html

Friends And Partners in Space (US & Russian Joint Efforts)
http://solar.rtd.utk.edu/~jgreen/fpspace.html

International Dark Sky Society: http://www.darksky.org/~ida/index.html

International Space Station Alpha: http://issa-www.jsc.nasa.gov/

Jet Propulsion Lab (info on Space Probes): http://www.jpl.nasa.gov/

Lick Observatory: http://www.ucolick.org/

Life on Mars? http://cu-ames.arc.nasa.gov/marslife/

The Nine Planets: (an excellent resource on solar system information)
http://seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html

The NASA Homepage: http://www.nasa.gov/

Project Galileo: http://www.jpl.nasa.gov/galileo/

Sky and Telescope: http://www.skypub.com

Sky Watcher's Diary: http://www.pa.msu.edu/abrams/diary.html

Space Shuttle Archives: http://shuttle.nasa.gov/

Space Telescope Info: http://www.stsci.edu/top.html

Weather Net: http://cirrus.sprl.umich.edu/wxnet/

Bibliography

Younger Students:

Branley, Franklyn M., *The Planets in our Solar System,* New York: Harper and Row, Harper Junior Books, 1987.

-------------------------- *The Sky is Full of Stars,* New York: Harper and Row, Harper Junior Books, 1981.

Cole, Joanna, *The Magic School Bus, Lost in the Solar System*, New York: Scholastic, Inc., 1990.

Fradin, Dennis B., *Comets, Asteroids, and Meteors,* Chicago: Children's Press, New True Books, 1984.

Rey, H.A.., *The Stars, A New Way to See Them,* Boston: Houghton Mifflin Co., 1976. (This is probably the best book for learning constellations for any age level.)

Ride, Sally & Okie, Susan, *To Space and Back,* New York: Lothrop, Lee & Shepard Books, 1986.

Older Students:

Beatty & Chaikin, *The New Solar System, 2nd Ed.* Cambridge: Cambridge University Press, 1990. (High school to college age level)

Couper & Henbest, *New Worlds, In Search of the Planets,* Reading, MA: Addison-Wesley, 1986.

Gallant, Roy, *Our Universe, 2nd Ed.,* Washington D.C.: National Geographic Society, 1986.

Miller & Hartmann, *The Grand Tour: A Traveller's Guide to the Solar System,* New York: Workman Publishing, 1981.

Moeschl, Richard, *Exploring the Sky, 100 Projects for Beginning Astronomers,* Chicago: Chicago Review Press, 1989. (Contains lots of project ideas for both teachers and older students.)

Pogue, William, *How Do You Go To The Bathroom in Space?* New York: Tom Doherty Associates, 1985. (Younger Readers may also enjoy this Q & A book about space flight.)

For Teachers:

Braus, Judy, Editor, *NatureScope: Astronomy Adventures,* Washington, D.C.: National Wildlife Federation, 1986.

Universe in the Classroom, Astronomical Society of the Pacific, Teacher's Newsletter, Dept. N. 390 Ashton Ave., San Francisco, CA 94112 (free to all teachers, request on school letterhead.)

Planetarium Program Evaluation

After the Northern Stars Planetarium has visited your class, please take a moment to fill out this evaluation. Your suggestions are very valuable to us!

Mail the completed evaluation to :......................Northern Stars Planetarium
15 Western Ave.
Fairfield, Maine 04937
Or Email To :...info@northern-stars.com

1. Show Name: ____

2.Group grade/age level:____

3. Was the material presented at an appropriate level for your class? ____________________

____

4. Was the amount of material discussed: Enough Overwhelming Not Enough

5. Should any parts of the presentation be developed further? __________. If so, which parts?

6. Was there sufficient time for questions and answers? Yes No

7. Were you studying astronomy or another related subject at the time of the planetarium's visit?

Yes No

If so, was the planetarium visit helpful? ______________________________

8. Was the Teacher's Guide helpful in preparing your class for the planetarium visit? Yes No

Which parts were most helpful? ______________________________

Which parts were least helpful? ______________________________

9. Did the presenter present the material in a clear and understandable fashion? __________

10. How would you rate the overall program given to your class in the planetarium? __________

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11. (Optional) Your name & school:______________________________

Thank you for your time! Your Comments Make a Difference!