Chapter 28 Stars and Galaxies	Name: Period:

SECTION 28.1: A CLOSER LOOK AT LIGHT

Objectives:

- Describe the characteristics of electromagnetic radiation.
- Explain techniques for analyzing light to obtain information about stars.
- Explain the Doppler effect and how it gives information about star motions.

Key Vocabulary:

- Electromagnetic radiation
- Continuous spectrum
- Electromagnetic spectrum
- Emission spectrum
- Absorption spectrum

A CLOSER LOOK AT LIGHT	Light is more than what we get when we turn on a lamp. Light also refers to a form of radiation that stars and other celestial objects emit. Most of what we know about the universe we have learned from analyzing the light that reaches us from distant stars and galaxies.
WHAT IS LIGHT?	Light is a form of _____, which is energy that travels in waves. Examples of electromagnetic radiation: 1. Music is broadcast using radio waves, 2. In hospitals, x-rays are used to produce images of your bones, 3. As you read, visible light gathered in by your eyes helps you to see. All types of electromagnetic radiation travel in the form of _____, at a speed of about 300,000 km per second (_____). The lengths of the waves determine the characteristics of each form of electromagnetic radiation. The distance from one wave crest to the next is called the _____. _____have the _____(longer than a soccer field), and _____have the _____.** DIAGRAM OF A WAVELENGTH:
DIAGRAM OF ELECTROMAGNETIC WAVES	

WHAT IS LIGHT?	The various types of electromagnetic radiation can be arranged in a continuum, with the _____ _____and the _____. This continuum is called the _____. Stars such as the sun emit a wide range of wavelengths. Electromagnetic waves _____. Electromagnetic waves emitted by an object provide information about the elements present in the object and about the object's motion.
THE SPECTROSCOPE	_____is actually made up of light of various colors, each with a different wavelength. These are the colors you see _____** or in the spectrum produced by light passing through a prism. _____has the _____, and _____has the _____. The band of colors we can see is called the _____. To separate starlight into its colors, astronomers use a tool called a _____, which uses a prism to split the light gathered by a telescope into a spectrum.**
TYPES OF VISIBLE SPECTRA	Spectroscopes break light into three different types of _____ (the plural form of _____): 1. A _____, 2. an _____, and 3. an _____. A _____ is an_____, which shows that its source is emitting light of all visible wavelengths. Continuous spectra are emitted by: 1. _____(such as the filament of an electric light), 2. _____ (such as molten iron),

	3. The _____inside stars. An _____ is a series of _____of different colors and brightness. The _____ that the _____is _____ of only _____. Glowing thin gases produce emission spectra. Since every element has a unique emission spectrum, scientists are able to identify the elements in objects by analyzing the spectra of light emitted. An _____is a _____ _____. These lines _____ when light from a _____ _____, which _____some of the _____. The elements in the gas absorb exactly the same wavelengths they would emit if they were in the form of glowing gases. By comparing emission and absorption spectra, scientists can determine what elements are present in the cooler gas that is absorbing some of the light. A _____indicates the _____of the _____.*** Our sun provides a good example. Scientists know that the photosphere and chromosphere absorb some of the sun's electromagnetic waves. By studying the absorption spectrum of the sun and comparing these with the emission spectra of gases tested in a laboratory, scientists have identified more than 67 elements in the sun's outer layer. _____can also be _____ the _____ _____(since a planet shines by reflecting sunlight). If the spectrum of a planet contains dark lines that are not found in the sun's spectrum, then these lines must be caused by substances in the planet's atmosphere.

THE DOPPLER EFFECT	The _____ is the apparent _____ _____in which there is relative motion between the source (another star or planet) and the receiver (our Earth). While examining the spectra of stars we can see that the dark lines of the _____ _____. The shift tells us the star is moving relative to Earth. If the star is _____the _____, the wavelength of _____ _____. The light waves "shift" toward the blue end of the spectrum. This is called _____. If the star is _____, the _____of light _____. The dark lines "shift" toward the red end of the spectrum. This is called _____. The blueshift or redshift can also _____toward or away from Earth.

SECTION 28.1 REVIEW

1. What do radio waves, visible light, and gamma rays all have in common?

2. What does a spectroscope do?

3. How do scientists use different spectra to figure out the composition of a star's outer layer?

4. Why is the light reaching us from some celestial objects shifted toward the red or blue end of the spectrum?

5. Every star has a unique spectrum. What does this suggest about stars?

SECTION 28.2: STARS AND THEIR CHARACTERISTICS

Objectives:

- Explain why the positions of constellations in the sky change with the seasons.
- List three units astronomers use to measure distances to stars.
- Describe the characteristics of stars, including mass, size, temperature, color, and luminosity.
- Describe variable stars.

Key Vocabulary

- Constellation
- Apparent magnitude
- Astronomical unit
- Light-year
- Parsec
- Luminosity
- Absolute magnitude
- Cepheid variable

STARS AND THEIR CHARACTERISTICS	Our sun is just one star among many. The light from other stars have traveled great distances to get to Earth. The light from Proxima Centauri (the star nearest the sun) left that star more than four years ago. Light from other stars and celestial objects may have taken thousands, millions, or even billions of years to get here.
CONSTELLATIONS	_____are a group of stars that appear to form a pattern in the sky. Officially, we recognize eighty-eight (88) constellations that can be viewed from Earth's northern and southern hemispheres. Ancient peoples named constellations for mythical heroes (Hercules), animals (Leo the lion, Taurus the bull), monsters (Draco the dragon, Centaurus the centaur), and familiar objects (Lyra the lyre or harp). The stars that make up a constellation actually are located at varying distances from Earth and are moving in relation to one another. However, because the stars are so far from Earth, it takes thousands of years before we notice any movement. A small star grouping, or sub-grouping of a constellation is called an _____. We are familiar with the constellation known as Ursa Major (the Great Bear). Within _____is the Big Dipper. The Big Dipper is an asterism in the shape of a dipper and handle. The two stars farthest from the Big Dipper's (Ursa Major) handle "_____" _____ _____(Polaris).** Polaris is found in the handle of the Little Dipper, an asterism of the Ursa Minor (the Little Bear) constellation. The _____of the _____across our sky is _____ _____– its rotation and revolution. Because Earth moves from west to east, the whole sky appears to turn, or move, from the east to the west. Sections of the sky directly above Earth's poles seem stationary as the Earth turns on its axis. Polaris (the North Star) seems fixed in the sky while the nearby stars move counterclockwise around it. These are called _____ _____ (stars that circle the poles). _____will never set below the horizon and can be _____

	long (Ursa Major, Ursa Minor, and Cassiopeia). _____can be _____. For example, in the Northern Hemisphere, _____ can best be seen in the _____. _____ can best be seen in the _____.*** _____in the constellations is _____ _____.***
APPARENT MAGNITUDE	The _____ of a star is a_____ _____to an observer on Earth. The _____ the apparent magnitude number, the _____ the star is. Some of the brightest stars in the sky are classified as_____. The faintest stars that can be seen with our unaided eye are called _____. Each magnitude differs from the next by a factor of about 2.5. Some stars are so bright that they have a negative apparent magnitude.
DISTANCES TO STARS	Because of the large distances in space, we have defined the average distance between the Earth and our sun as one Astronomical Unit. This is written as 1 AU. _____ The next nearest star past our sun is called Proxima Centauri. Proxima Centauri is more than 260,000 AU from Earth. Scientists use two other units that cover large distances in space. _____ = a light year is the _____ _____.*** This is equal to about 9.5 trillion kilometers. Proxima Centauri is about 4.2 light-years away from Earth. _____is a _____ _____.

	Because Earth orbits the sun, astronomers experience parallax when they observe the stars. Astronomers can _____, by knowing the angle between two observed positions and the distance between the observation points. To express these measurements, astronomers use a special unit of distance called a _____. A parsec is a "parallax second", and is equal to 3.258 light-years.
ELEMENTS IN STARS	A _____ is a sphere of super-hot gases, _____, *** although one or two percent of a star's mass may consist of heavier elements (oxygen, carbon, nitrogen, sodium). At its surface, our sun is about 69% hydrogen, 29% helium, and about 2% of heavier elements. Although _____, no two stars contain exactly the same elements in the same proportion. Astronomers use spectral analysis to determine a star's makeup.
MASS, SIZE & TEMPERATURE OF STARS	Stars vary greatly in their masses, size, and densities. We cannot observe a _____directly. We can only calculate it based on other observations. It can be _____ either by the _____ or by its _____.*** The larger the mass, the stronger the gravitational effect on the bodies around it. Stellar masses are expressed as multiples of the mass of our sun, which is called _____. _____. The smallest stars are smaller than Earth. The largest star known has a diameter more than 2000 times that of our sun. _____. Betelgeuse is about one ten-millionth as dense as our sun. However, one star near Sirius is so dense that one teaspoon of it would weigh more than a ton on Earth.

TEMPERATURE AND COLOR OF STARS	_____. The range of colors a star emits depends on its surface temperature. _____(below 3900° C) results in a _____ (for example, Betelgeuse). Hotter temperatures change the color to orange, then yellow (our sun, at about 5500° C), and then white. The_____(such as Sirius) have a _____ _____(above 9500° C).
LUMINOSITY AND ABSOLUTE MAGNITUDE	_____ is the _____. Luminosity _____. Distance from Earth <u>is not</u> a factor. <u>If two stars have the same surface temperature, the larger star would be more luminous</u>.*** If two stars have the same size, the hotter star would be more luminous. _____ is a _____ _____(ten parsecs) _____. Thus, distance from Earth no longer becomes a factor in how bright a star is. Remember, very bright stars that are very far from Earth may appear to be very faint to us. For example: Since our sun is so close to Earth, it has an apparent magnitude of –26.7. However, the sun has an absolute magnitude of only +4.8.
VARIABLE STARS	Most stars shine with a steady brightness. _____ show a regular variation in brightness over cycles that last from days to years. There are several different kinds of variable stars. 1. _____ change in brightness as they expand and contract. Contracting (hotter) = brighter, expanding (cooler) = dimmer.

	2. An important class of pulsating stars are called _____. These are yellow supergiants whose cycles of brightness range from about 1 day to 50 days (5 is average). The absolute magnitude of a Cepheid is related to the length of time between its periods of maximum brightness. The slower the cycle, the greater the luminosity of the star. By _____ a _____, astronomers can determine the distance from Earth to the star. This _____ _____that contain Cepheid's.*** 3. A nonpulsating "star" may change brightness because it actually is two or more stars. Most stars are parts of systems in which two or more stars revolve around each other. These star systems are called _____ _____. From Earth, it appears that one star eclipses (passes in front of) another star. This causes the "star" system to dim at regular intervals. Algol is a bright star that is eclipsed by a dim companion. Algol's brightness appears to decrease by about 1/3 every 2.9 days.
TELESCOPES	Telescopes help astronomers in two ways: 1. They collect far more light than an unaided eye can. 2. They magnify images so you can see more detail and to visually separate distant objects from one another. _____ use lenses or mirrors to gather and focus starlight. Most lenses or mirrors are round, so doubling the radius of the lens or mirror increases its light-gathering power four times. The best locations for optical telescopes are on mountain peaks in dry climates. These telescopes can only work after the sky becomes dark. _____use lenses both to focus light and to magnify an image for viewers. These are the original type of telescope. _____use one mirror to focus light and a second mirror to reflect the light to the eyepiece. If the telescope uses an array of smaller mirrors (in place of one larger objective mirror) it is called a

	_____ telescope or MMT. Both refracting and reflecting telescopes have a lens in the eyepiece. Radio telescopes are often used in arrays (arrangements of multiple telescopes so they can act like one large telescope). In addition to radio waves, astronomers also gather data from ultraviolet light, X rays, gamma rays, and infrared wavelengths when studying celestial objects. Much of these wavelengths are absorbed by our atmosphere, so to collect data on these wavelengths, we use high flying aircraft, balloons, rockets, and satellites. Several infrared telescopes are found on Earth, however, they are usually built high up on mountain tops. They must be kept very cool if they are to detect weak infrared sources in space.

SECTION 28.2 REVIEW

1. How do constellations differ from other groupings of stars, such as galaxies?

2. What is a light-year? A parsec?

3. Copy and complete the concept map.

4. What is the connection between a star's surface temperature and its color?

5. Would the sun be more luminous if it were the same size but hotter? If it had the same surface temperature but were more massive. Explain.

SECTION 28.3: LIFE CYCLES OF STARS

Objectives:

- Describe the birth of a star
- Compare and contrast the life cycle of a star like the sun and a star more massive than the sun.
- Describe the remnants of supernovae.

Key Vocabulary:

- Main sequence
- Giant star
- Supergiants
- White dwarfs
- Planetary nebula
- Supernova
- Neutron star
- Pulsar
- Black hole
- Nebula

LIFE CYCLES OF STARS	Stars are born from great clouds of gas and dust. They will mature, grow old, and die. When they die, they may produce new clouds of dust, from which new stars and planets may be formed. _____.
THE HERTZSPRUNG-RUSSELL DIAGRAM	The stars in the universe are at different stages in their life cycles. Some stars are young and hot; others are older and colder. The _____(or H-R Diagram) gives us a picture of a star's life. Named for astronomers Ejnar Hertzsprung (of Denmark) and Henry Norris Russell (of the United States). The H-R diagram _____(brightness) of stars _____ _____. Most stars fall into distinct groups in the H-R diagram, because the groups represent stages in the life cycles of the stars. _____seem to fit in a band that runs from the upper left of the diagram to the lower right. This band is called the _____. The stars in this band are called _____. Main-sequence stars vary in surface temperature and absolute magnitudes. However, _____ main-sequence stars are _____. Above the main-sequence stars are _____. Giant stars are more luminous and have diameters from 10-100 times greater than our sun. _____are giant stars that have diameters more than 100 times greater than our sun. These giant stars (but relatively cool) are very luminous. Also included on the H-R diagram are _____. These are stars that are near the end of their lives. These were once red giant stars that have lost their outer atmosphere and are now only a glowing stellar core. Red giant → loses outer atmosphere = white dwarf

BIRTH OF A STAR	A star begins its life as a cloud of gas and dust called a _____. About 99% of a nebula consists of gas (mostly hydrogen) and the remaining 1% is a kind of dust made of very tiny grains. • The nebula starts to compress when pushed by an outside force (such as a shock wave) • Gas and dust move closer together (because of gravity) • Regions become denser, and temperatures start to go up • In large nebulas, parts of it will start to glow • Glowing areas are called protostars • Gravity continues to cause contraction • Protostars get hotter and hotter • When the protostar's center gets hot enough, a fusion reaction begins • A new star is born!

CHECKING FOR UNDERSTANDING – REQUIRED FOR YOUR CLASS NOTES GRADE (AT LEAST ONE PARAGRAPH = 7 COMPLETE SENTENCES)

SUMMARIZE – IN YOUR OWN WORDS – THE BIRTH OF A STAR

DEATH OF A STAR LIKE THE SUN	Main-sequence stars like the sun remain about the same size for millions or even billions of years. Hydrogen in the core of the star continues to fuse into helium. The energy being produced balances the force of gravity. Eventually, the hydrogen core shrinks, producing additional heat, which triggers hydrogen fusion outside the core. The entire star begins to expand. Core temperature rises and helium fuses into heavier elements (carbon and oxygen). The star begins to die. A carbon-oxygen core forms, while hydrogen and helium fusion continues in the layers surrounding the core. Surface gases begin to blow away in abrupt bursts. Eventually all the gases are gone, and only the carbon-oxygen core remains. This is what we call a _____ _____. Ultraviolet emissions from the white dwarf are absorbed by the nearby gases. This gives off visible light (glowing). This glowing halo of gases is called a _____. (early astronomers thought they looked like the disks of planets) After 25,000 years, the planetary nebula will dissipate into space, leaving only the white dwarf.
DEATH OF A MASSIVE STAR	Stars eight or more times massive than our sun have a different life cycle. In massive stars, as hydrogen runs out, fusion continues until iron nuclei are formed. The star then swells to more than 100 times the diameter of the sun, becoming a _____. The iron nuclei don't release energy (like hydrogen), instead they absorb energy. This causes the iron core too quickly and suddenly collapse. The collapse produces a shock wave that blasts the star's outer layers into space at thousands of miles per second, and produces a brilliant burst of light. The explosion is called a _____. This nova is 10-100 times as bright as our sun. The explosion produces many elements, including copper, uranium, silver, and lead. These elements are blown away into space as a huge cloud of gas and dust, mixing with what was already there.

REMNANTS OF MASSIVE STARS	After a star goes supernova, it leaves behind its core. Sometimes this is a _____. This star is named this way because the gravitational force is so great that each atom's electrons are crushed into the nucleus. A _____ is for the most part a dense mass of neutrons. While neutron stars are typically about 20 km in diameter, they are trillions of times more dense than the sun. When they are first formed, neutron stars spin rapidly, giving off bursts of radio waves. Beams of radiation sweep through space like a searchlight. Astronomers call these rapidly spinning neutron stars a _____ (because of the pulses of energy). A _____ is the remnant of a star at least 15 times as massive as the sun. Inside a black hole, the mass of 10 suns may be condensed inside an area 30 kilometers wide. <u>How do we identify black holes</u>? Black holes are a _____. Astronomers believe that atoms are emitting x-rays as they are ripped apart by the force of gravity within the black hole. A black hole is thought to be at the center of our Milky Way galaxy.

CHECKING FOR UNDERSTANDING – REQUIRED FOR YOUR CLASS NOTES GRADE (AT LEAST TWO PARAGRAPHS = 10 COMPLETE SENTENCES)

COMPARE AND CONTRAST THE LIFE AND DEATH CYCLE OF AN AVERAGE STAR LIKE THE SUN AS COMPARED TO A MASSIVE STAR

SECTION 28.3 REVIEW

1. What does the Hertzprung-Russell diagram depict?

2. What forces balance each other in a main-sequence star?

3. Describe the end of a massive star's life.

SECTION 28.4: GALAXIES AND THE UNIVERSE

Objectives:

- Tell what a galaxy is and describe the various types of galaxies.
- Explain the origin of the universe according to the big bang model.

Key Vocabulary:

- Galaxies
- Quasar
- Big bang model

GALAXIES AND THE UNIVERSE	The _____is everything that exists. The _____ is everything we can observe. Astronomers are not sure how old the universe is, but current estimates range from 10-20 billion years.

WHAT ARE GALAXIES?	_____are systems that contain millions or even billions of stars. Most estimates place the number of galaxies in the observable universe at 50-100 billion. Space is so vast that most galaxies are light-years apart. We are part of the _____. Our star is only one among hundreds of billions. The Milky Way galaxy is a _____ that is shaped like a thin disk with a central bulge.*** The diameter of the Milky Way is about 100,000 light-years. Its greatest thickness is about 10,000 light-years. The sun is about 26,000 light-years from the Milky Way's center. The "milky" haze in the night sky is the large number of stars that are in this region of the sky. The Milky Way belongs to a group of more than 30 galaxies called the _____. *** The Milky Way's nearest neighbors in the Local Group are the two Magellanic Clouds, which can be seen without a telescope in the Southern Hemisphere. The Andromeda Galaxy is faintly visible in the Northern Hemisphere with the unaided eye.
TYPES OF GALAXIES	No two galaxies are exactly alike. Most galaxies can be classified by shape. _____ (like the Milky Way) come in a range of types – from ones with large, bright nuclei of stars and tightly wound spiral arms, to ones with very small, dim nuclei and open sprawling arms. The Andromeda Galaxy is also a spiral galaxy. _____ range from nearly spherical to lens-shaped. Their stars are concentrated in their centers, and they have no arms. Elliptical galaxies _____ _____(than spiral galaxies), and contain few, if any, young stars. The galaxy called M87 is an elliptical galaxy. _____ have irregular shapes and are much smaller and fainter than both spiral and elliptical galaxies. _____ _____. The two Magellanic Clouds are irregular galaxies.

ACTIVE GALAXIES	The Milky Way is a _____. A normal galaxy is one where the _____ _____by the galaxy _____ the _____ by all the galaxies _____.*** _____ are those where _____ _____. *** Some emit large amounts of radiation while others change in brightness considerably over short periods of time. Super massive black holes located at the center of these galaxies may be the reason for large amounts of radiation. _____are extremely distant objects, some as far away as 12 billion light-years, that are perhaps a hundred to even a thousand times brighter than a normal galaxy. Quasars may be highly active galactic nuclei. A _____is believed to be an active galaxy that has one of its jets of hot gas pointed directly at Earth, so we are looking directly into the jet of escaping energy. _____ active galaxies are thought to be weaker versions of quasars.
ORIGIN OF THE UNIVERSE – THE BIG BANG MODEL	Scientists cannot say where or how the universe originated. However, through observations and experiments they have put together a model about how the universe has developed. This model is called the _____. The big bang model explains the history of the universe from a tiny fraction of a second after it came into being up to the present time. • According to the _____, 10-20 billion years ago all matter existing in an incredibly hot and dense state. • Matter expanded and cooled, slowly condensing into stars and galaxies. • The first stars consisted mostly of hydrogen with a small amount of helium. • No planets orbited yet, heavier elements did not yet exist. • More and more stars formed, matured, and died, making more and more heavier elements. • Supernovas and dying red giants released the heavier elements into space. • Eventually our sun and its nine planets were formed from interstellar gas and dust.

CHECKING FOR UNDERSTANDING

- **Write a paragraph explaining in your own words the big bang model. (REQUIRED FOR YOUR CLASS NOTES GRADE). MINIMUM 7 SENTENCES.**

EVIDENCE FOR THE BIG BANG MODEL	• The _____ _____ (Edwin Hubble found redshifts in galaxies he studied).*** • _____(radiation left over from the universe's beginning).***

SECTION 28.4 REVIEW

1. What is the difference between the universe and the observable universe?

2. Into what basic shapes can most normal galaxies be classified?

3. How do active galaxies differ from normal galaxies?

4. Copy and complete the **concept map** concerning what we know about the universe.

5. Observations of very distant galaxies show that they are at an earlier stage of development than nearby galaxies. How do these observations support the big bang model?