Overview:

Students will research the four stages of the life cycle of a star then further research the ramifications of the stage of the sun on Earth.

Objectives:

The student will:

- research, summarize and illustrate the proper sequence in the life cycle of a star;
- share findings with peers; and
- investigate Earth's personal star, the sun, and what will eventually come of it.

Targeted Alaska Grade Level Expectations:

Science

[9] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[9] SD4.1 The student demonstrates an understanding of the theories regarding the origin and evolution of the universe by recognizing that a star changes over time.

[10-11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

[10] SD4.1 The student demonstrates an understanding of the theories regarding the origin and evolution of the universe by recognizing phenomena in the universe (i.e., black holes, nebula).

[11] SD4.1 The student demonstrates an understanding of the theories regarding the origin and evolution of the universe by describing phenomena in the universe (i.e., black holes, nebula).

Vocabulary:

black dwarf – the celestial object that remains after a white dwarf has used up all of its hydrogen fuel and no longer gives off detectable radiation; made mostly of carbon

black hole – an extremely dense celestial object that has a gravitational field so strong that nothing can escape, not even light; formed by the collapse of a massive star's core in a supernova

massive star – a classification for a star that is at least eight to 100 times the mass of our sun

nebula – a thinly spread cloud of interstellar gas and dust; it will appear as a bright patch in the night sky if it reflects light from nearby stars, emits its own light, or re-emits ultraviolet radiation from nearby stars as visible light; if it absorbs light, the nebula appears as a dark patch; in dark nebulae, stars form from clumps of hydrogen gas

neutron star – an extremely small (10 km in diameter) extremely dense star with a powerful gravitational pull; considered in the final stage of stellar evolution; some neutron stars, known as pulsars, pulse radio waves into space as they spin

nuclear fusion – the process by which two or more atomic nuclei join together, or "fuse", to form a single heavier nucleus; usually accompanied by the release or absorption of large quantities of energy; the difference in mass is converted into energy represented by the equation E=mc2; suns are powered by nuclear fusion, mostly converting hydrogen into helium

planetary nebula – a nebula consisting of an expanding shell of gas, mostly hydrogen, that surrounds a hot, compact central star

protostar – a stage in the evolution of a young star after it has fragmented from a interstellar gas cloud, but before it has collapsed sufficiently for nuclear fusion reactions to begin

pulsar – a spinning neutron star that emits radiation, usually radio waves, in very short and very regular pulses; because a pulsar's magnetic poles do not align with the poles of its axis, its beams of radiation sweep around like the beacon of a lighthouse emitting intense bursts of radio waves at regular intervals

red giant – a star of great size and brightness that has a relatively low surface temperature, making it appear red; indicates a star nearing the end of its life cycle; when a star begins to lose hydrogen and burn helium instead, it gradually collapses, and its outer region begins to expand and cool; the sun will become a red giant in several billion years

star – a celestial body that produces its own light and consists of a mass of plasma held together by its own gravity; nuclear fusion in the core of a star is the source of its energy; any of the celestial bodies visible at night from Earth as relatively stationary, usually twinkling points of light, including binary and multiple stars

sun – the star that is orbited by all of the planets and other bodies of our solar system and that supplies the heat and light that sustain life on Earth; it has a diameter of about 864,000 miles (1,390,000 kilometers) and a mass about 330,000 time that of Earth

supernova – a massive star that undergoes a sudden, extreme increase in brightness and releases an enormous burst of energy; this occurs as a result of the violent explosion of most of the material of the star, triggered by the collapse of its core

white dwarf – a whitish star that is very dense and very small, about the size of Earth; a white dwarf remains after the central star of a planetary nebula burns out and becomes cool and dim; indicates a star at the end of its life

Whole Picture:

Stars form from nebulas, which are huge regions of concentrated dust and gas. The dust and gas respond to the forces of gravity and begin to collide, contract and heat up. During this process a tiny star, called a protostar, is formed. The young star further collapses and begins nuclear fusion.
Most nuclear fusion is the process of turning hydrogen into helium.

The mass of the star determines much of the rest of the life cycle. A star begins to "die" when it runs out of hydrogen. It begins to expand and, as it does so, it cools. This cooling makes it appear red. Once it runs completely out of fuel for fusion it shrinks under its own gravity, further cools and, depending on its original mass, turns into a white dwarf, a neutron star or a black hole. Low- and medium-mass stars become a white dwarf. High-mass stars experience a supernova and become a neutron star or black hole.

Materials:

- Research materials (Astronomy text books, encyclopedias, Internet, etc.)
- Scissors (one per group)
- Construction paper or blank copy paper (several pieces per group)
- Clear tape
- Glue stick (one per group)
- Colored pencils or markers (one set per group)
- Multimedia projector
- STUDENT WORKSHEET: "A Star is Born"
- STUDENT WORKSHEET: "The Sun"
- VISUAL AID: "Life Cycle of the Sun"

Activity Preparation:

1. Find and bookmark Internet sites showing the sun and diagrams of the life cycle of a star. In addition, search for videos that explain the process. NASA, YouTube and TeacherTube have such resources.
   Here is a video on NASA's website: http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Lifecycle_of_a_Star.html
   Here is one on TeacherTube: http://www1.teachertube.com/viewVideo.php?video_id=73345.
2. Bookmark the following website on student computers: http://www.michielb.nl/sun/kaft.htm Students will use the site to complete STUDENT WORKSHEET: "The Sun".
3. Print out student worksheets and prepare materials.

Activity Procedure:

1. Introduce topic. Show students video about the life cycle of stars. Remind students our sun is a star that is currently experiencing such a cycle, though scientists estimate it has about five billion years before it cools. Show students bookmarked Internet site depicting the life cycle of star.
2. Explain students will now further research the life cycle of a star using classroom and library resources such as available textbooks, encyclopedias and the Internet. Divide students into small groups and hand out STUDENT WORKSHEET: "A Star is Born." Explain each section on the worksheet represents a part of the life cycle of a star, however, the sequence of events is out of order. Small groups will work together to figure out the correct sequence, cut apart the incorrect sequence and re-order, then glue each sequence to a piece of paper.
3. When groups have completed the sequencing, ask groups to share findings about each part of the life cycle until they have all been discussed (in order). As students share, if the sequence is incorrect, take the opportunity to discuss and correct. (See "Answers" for correct sequence.)
4. (Optional) Ask students to prepare their information for display. Using available classroom materials, such as construction paper, colored pencils, markers, etc., student must illustrate each section of the life cycle of a star. They may design a poster, timeline, mobile or other teacher-approved project. If a color printer is available, images from the Internet can be used, as well.
5. Display VISUAL AID: "Life Cycle of the Sun." Hand out STUDENT WORKSHEET: "The Sun" and choose a reading strategy best suited for the class to review the background information. Explain students will use an Internet multimedia tool to further explore the Sun. The VISUAL AID will also help as students complete the worksheet.

Extension Ideas:

1. Students add to their display:
   - the length of time for each stage of a star's life; and
   - the sizes of the stars in the various stages.
2. Research event horizon, super-mass black hole, super nova, nebula, etc. and find pictures of these celestial objects to display with the life cycle of a star.
3. Find and bookmark online astronomy games for students to play for review and extension. For example the Space Science Institute offers online games: http://www.scigames.org/

Answers:

STUDENT WORKSHEET: "A Star is Born"

SECTION ONE: A Star is Born!

1. Gravity begins to pull together particles of dust and gases in an enormous nebula, a cloud in space.
2. Over time, the gases and dust have collected to form a giant ball.
3. In the core of the ball, the temperature increases due to the motions of the particles and the pressure from all the surrounding particles.
4. When the temperature reaches 15 million degrees Kelvin, nuclear fusion begins.
5. The energy released by the fusing nuclei moves outward to be released as electromagnetic radiation.
6. The star glows.
7. The star forms, varying in color, temperature, and size due to the mass of the gases and particles from which they were formed.
8. The greater the mass of the star, the larger and hotter the star becomes.

SECTION TWO: A Star in Middle Age

1. During the middle years of a star's life the star fuses hydrogen into helium and releases tremendous amounts of energy.
2. The energy produced by continuous fusion pushes outward and balances the inward pull of gravity.

3. The star burns and burns.

SECTION THREE: A Star in Old Age

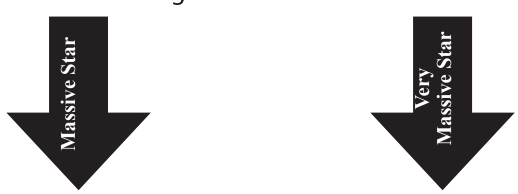
1. In the later years of a star's life, hydrogen begins to run out and the core begins to cool.
2. Without the constant energy from fusion pressing out, the outer layers of the star begin to collapse from the pull of gravity.
3. The collapse causes the temperature and pressure to rise.
4. As the star becomes hotter, it expands to become a red giant.

SECTION FOUR: The Death of a Low-Mass Star

1. As the red giant's outer layers expand, the core begins to collapse.
2. As the core collapses, the helium atoms in the core fuse into carbon atoms releasing energy until all the helium is fused.
3. The star now has a carbon core, which is not compressible and stabilizes.
4. With the core stabilized, the outer layers are shed as a planetary nebula.
5. The star no longer produces energy but is cooling as a white dwarf.
6. A white dwarf is composed of the second densest matter in the universe.
7. Once completely cooled no light will be given off and the white dwarf becomes a dead black dwarf.

The Death of High-Mass Stars (Massive & Very Massive)

1. As the red giant's outer layers expand to a super red giant, the core begins to collapse due to gravity.
2. The collapsing core produces a new nuclear reaction forming iron, and stops shrinking.
3. Once the fusion has produced an iron core, fusion stops.
4. When fusion stops, the star collapses and the temperature in the core reaches 100 billion degrees.
5. The very hot atoms in the core repulse each other and overcome the force of gravity in a shock wave.
6. The shockwave propels the materials away from the star in a huge explosion called a supernova.
7. The explosion blows newly formed elements into the universe to become parts of new stars, planets, and other space objects.
8. The leftover core of these massive stars continues to condense.
9. Electrons are joined with protons to form neutrons.
10. The whole core of the star becomes nothing but a dense ball of neutrons.



More about the Death of a High-mass Star

MASSIVE STAR

Neutron stars, the densest material in the universe, spin very rapidly and produce an enormous magnetic field.

Stars that are greater than five times the mass of our sun but less than 15 times greater become neutron stars.

Some neutron stars, called pulsars, radiate x-rays and gamma rays in pulses as they rotate.

In a neutron star the core of neutrons is stable and the core remains.

More about the Death of a High-mass Star

VERY MASSIVE STAR

The black holes that form are so dense that not even light can escape.

In these very massive stars, the core of neutrons is unstable, due to the gravitational forces and pressures, and collapses forming a black hole.

Stars that are greater than 15 times the mass of our sun continue to collapse until they become black holes.

An event horizon is the point where objects approaching the black hole can no longer escape.

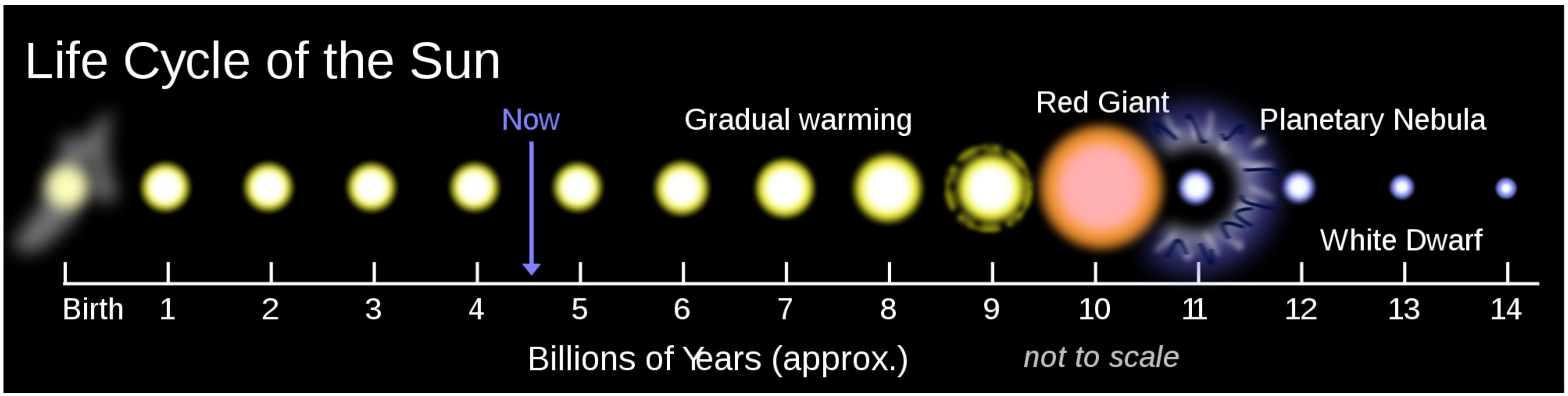
Ther are huge black holes referred to as galaxy-mass black holes, which are the mass of a galaxy.

These huge black holes are thought to be at the center of galaxies that may have the mass of 10 to 100 billion stars.

Black holes don't have a surface, they have an event horizon.

STUDENT WORKSHEET: "The Sun"

1. about half
2. photosphere
3. solar flares
4. corona
5. about one million degrees Kelvin; hotter
6. solar wind
7. white dwarf
8. Earth will not survive. It will eventually become too hot to be inhabited.
9. Answers will vary.


Life Cycle of the Sun
Now
Gradual warming
Red Giant
Planetary Nebula
White Dwarf
Birth
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Billions of Years (approx.)
not to scale

NAME: ____________________________

A STAR IS BORN

Directions: Each section represents part of the life cycle of a star, however the sequence is out of order. Using available resources, research each section to learn the correct sequence of events. Cut apart the incorrect sequence then rearrange to the correct order. Glue the strips to a piece of construction paper. Leave room for illustration.

SECTION ONE

A Star is Born! (The birth of a star)

The star forms, varying in color, temperature, and size due to the mass of the gases and particles from which they were formed.

Gravity begins to pull together particles of dust and gases in an enormous nebula, a cloud in space.

When the temperature reaches 15 million degrees Kelvin, nuclear fusion begins.

The star glows.

In the core of the ball, the temperature increases due to the motions of the particles and the pressure from all the surrounding particles.

The greater the mass of the star, the larger and hotter the star becomes.

Over time, the gases and dust have collected to form a giant ball.

SECTION TWO

A Star in Middle Age

The energy produced by continuous fusion pushes outward and balances the inward pull of gravity.

During the middle years of a star’s life, the star fuses hydrogen into helium and releases tremendous amounts of energy.

SECTION THREE

A Star in Old Age

As the star becomes hotter, it expands and becomes a red giant.

The collapse causes the temperature and pressure to rise.

In the later years of a star's life, hydrogen begins to run out and the core begins to cool.

Without the constant energy from fusion pressing out, the outer layers of the star begin to collapse from the pull of gravity.

The last stages of a star's life are dependent on its mass. In section four, you will have two sequences – one for a low-mass star and one for a high-mass star. A high-mass star can take more than one path.

SECTION FOUR

Death of a Low-Mass Star

A white dwarf is composed of the second densest matter in the universe.

The star can no longer produce energy but is cooling as a white dwarf.

The star now has a carbon core, which is not compressible and stabilizes.

With the core stabilized, the outer layers are shed as a planetary nebula.

As the core collapses, the helium atoms in the core fuse into carbon atoms releasing energy until all the helium is fused.

Once completely cooled no light will be given off and the white dwarf becomes a dead black dwarf.

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The Death of High-Mass Stars

Once the fusion has produced an iron core, fusion stops.

The leftover core of these massive stars continues to condense.

The collapsing core produces a new nuclear reaction forming iron and stops shrinking.

The shockwave propels the materials away from the star in a huge explosion called a supernova.

As the red giant's outer layers expand to a super red giant, the core begins to collapse due to gravity.

The explosion blows newly formed elements into the universe to become parts of new stars, planets, and other space objects.

When fusion stops, the star collapses and the temperature in the core reaches 100 billion degrees.

Electrons are joined with protons to form neutrons.

The very hot atoms in the core repulse each other and overcome the force of gravity in a shockwave.

The whole core of the star becomes nothing but a dense ball of neutrons.

NAME: ______________________________

A STAR IS BORN

Here are some extra facts about the different paths a high-mass star can take, depending on its mass. Add the arrows and boxes to the sequence for the death of a high-mass star. (You do not need to cut apart the sentences. The boxes can stay intact.)

More about the Death of a High-mass Star

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NAME: ______________________________

STUDENT WORKSHEET

THE SUN

Background Information: The easiest star to study is the sun. (The next closest star, Proxima Centauri, is about 4.2 light years from Earth.) The sun contains about 99 percent of the total mass in our solar system. The mass of the sun in scientific notation is 1.98892 Ã x 1030 kilograms. That's 1,988,920,000,000,000,000,000,000,000,000 kilograms, which is 333,000 times the mass of Earth. To contrast the difference in volume, more than 1.3 million planet Earths could fit inside the sun.

About 75 percent of the sun's mass is hydrogen. The rest is mostly helium with trace amounts of heavier elements. The sun gets its energy by nuclear fusion – combining protons in hydrogen nuclei to form helium, a heavier element with a smaller mass. The extra mass is converted to energy. Simply put, four hydrogen atoms become one helium atom plus energy in the form of light. About 5 trillion grams of mass are lost each second because of nuclear fusion.

Directions: Using a Web browser, access The Virtual Sun at http://www.michielb.nl/sun/. Find the answers to the following questions:

1. Approximately how much of the hydrogen in the sun's core has been fused into helium?

   ____

2. What is the surface of the sun called? ____

3. Just outside the surface lies the chromosphere. Plasma is taken along the magnetic field lines of the sun to create

   ____

4. What portion of the sun is visible only during a solar eclipse? ____________________________

5. What is the temperature of the corona?____________________ Is this hotter or cooler than the surface of the sun? ________________

6. The constant stream of particles flowing away from the sun is known as ______________________

7. Scientists estimate the sun has about 4.5 billion years left in its life cycle before it will become first a red giant, then a ____________________________ and continue to cool indefinitely.

8. Based on what you have learned, what is the predicted fate for Earth? ______________________

   ____

Critical Thinking Question:

9. What do you see as the potential solution for mankind, if any? Explain. ______________________

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