A STAR IS BORN – STAGES COMMON TO ALL STARS

All stars start as a nebula. A nebula is a large cloud of gas and dust. Gravity can pull some of the gas and dust in a nebula together. The contracting cloud is then called a protostar. A protostar is the earliest stage of a star’s life. A star is born when the gas and dust from a nebula become so hot that nuclear fusion starts. Once a star has “turned on” it is known as a main sequence star. When a main sequence star begins to run out of hydrogen fuel, the star becomes a red giant o red super giant.
THE DEATH OF A LOW OR MEDIUM MASS STAR

After a low or medium mass star has become a red giant the outer parts grow bigger and drift into space, forming a cloud of gas called a **planetary nebula**. The blue-white hot core of the star that is left behind cools and becomes a **white dwarf**. The white dwarf eventually runs out of fuel and dies as a **black dwarf**.

THE DEATH OF A HIGH MASS STAR

A dying red super giant star can suddenly explode. The explosion is called a **supernova**. After the star explodes, some of the materials from the star are left behind. This material may form a neutron star. **Neutron stars** are the remains of high-mass stars. The most massive stars become **black holes** when they die. After a large mass star explodes, a large amount of mass may remain. The gravity of the mass is so strong that gas is pulled inward, pulling more gas into a smaller and smaller space. Eventually, the gravity becomes so strong that nothing can escape, not even light.

**Question Sheet**

Just like living things and humans, stars have a life cycle, which consists of birth, growth, development, middle age, old age, and death. The life cycle of a star spans over billions of years.

**Section One - Sequencing (1-6)**

The stages below are not in the right order. Number the stages in the correct order.

6. The star begins to run out of fuel and expands into a **red giant** or **red super giant**.

1. Stars start out as diffused clouds of gas and dust drifting through space. A single one of these clouds is called a **nebula**

5. What happens next depends on the mass of the star.

3. Heat and pressure build in the core of the **protostar** until **nuclear fusion** takes place.

2. The force of gravity pulls a nebula together forming clumps called **protostars**.

4. Hydrogen atoms are fused together generating an enormous amount of energy igniting the star causing it to shine.
Section Two - Vocabulary
Match the word on the left with the definition on the right.

C black dwarf  a. star left at the core of a planetary nebula
E white dwarf  g. a red super giant star explodes
B nebula  c. what a medium-mass star becomes at the end of its life
D protostar  b. a large cloud of gas or dust in space
G supernova  a. exerts such a strong gravitational pull that no light escapes
F neutron star  d. the earliest stage of a star’s life
A black hole  f. the remains of a high mass star

Section Three – Understanding Main Ideas - Low Mass Star

1. Red giant
2. Where fusion begins
3. Nebula
4. Black hole dwarf
5. The stage the sun is in
6. White dwarf
7. Planetary Nebula

Label the diagram with all the words given as well as write down the Letter that matches each object.
Section Four – Understanding Main Ideas - High Mass Star

1. Black Hole
2. Supernova
3. Protostar
4. Gravity causes this to condense into a protostar
5. Main sequence star
6. When a star begins to run out of fuel and grows larger
7. Neutron star

Section Five – Graphic Organizer – Putting it all Together
- Black hole
- Protostar
- Supernova
- Neutron stars
- White dwarf
- Planetary nebula
- Red Giant or Supergiant

Nebula → Protostar → Red Giant or Supergiant

- Stars with small and medium mass
  - Planetary nebula
  - White dwarf

- Stars with high mass
  - Supernova
    - Most massive
    - High mass
      - Black hole
      - Neutron stars

- Black dwarf
Section Six  Use the following words to fill in the blanks

<table>
<thead>
<tr>
<th>Black hole</th>
<th>Average</th>
<th>Massive</th>
<th>White dwarf</th>
<th>Supernova</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutron star</td>
<td></td>
<td>Nebulae</td>
<td>Super-giant</td>
<td>Neutron</td>
</tr>
</tbody>
</table>

1. Nebulae are clouds of dust and gas from which a star first forms. They are pulled together by gravity into a spinning disc. The center of the disc becomes a star while the rest can become a system of planets.

2. Super-giant come from giant or massive stars. They grow to as much as three times the mass of our sun as they lose the nuclear fuel at their core. The outer layer of this red star expands as the core contracts.

3. Nebula can form either an average star that is about the size of our Sun or a massive star which can be over three times as big as our Sun! These stars stay in this period for most of their lives and they convert hydrogen to helium while generating lots of heat and light.

4. At the end of the life of a giant star, a supernova is resulted when a red supergiant's core collapses in on itself. The electrical forces at the center of the star overcome the gravitational pull and create a massive explosion that scatters the outer layers of the red supergiant.

5. The outer layers of a red giant keep expanding until they eventually drift off and form a planetary nebula.

6. Eventually the outer layers of an average star drift away and the star becomes a much smaller white dwarf. It has now run out of nuclear fuel to burn off.

7. This star is very small and tremendously dense and marks the end of the supergiant's life cycle. It has a strong magnetic field, a very fast spin and is about 1.4 times the mass of the sun - it is called a neutron star.

8. If the star is very massive or big enough, a black hole is formed, which is so dense that not even light can escape its gravitational pull!
Section 7  Crossword Puzzle on the Life Cycle of Stars

Across

1. a white dwarf that has cooled down in temperature; is invisible because it no longer emits light
2. one of the endings of a star that has a mass 4-8 times greater than our Sun; are very dense
3. this is what a low or medium life star will become later in its life; typically have the same mass as our Sun, but only a bit larger than the Earth
4. the explosion of a star when it has reached the end of its lifetime; are no longer stars, and are seen as bright points of light in the sky
5. the dying stage of a star; they become larger
6. and this color due to the decrease in temperature
7. burn up their fuel more quickly than regular stars; soon all fuels will run out and the core will collapse
8. places in space so strong that not even light can escape; may occur when a star is dying

Down

1. this may be the beginning or the end of a star’s life; a cloud that is made up of dust, helium and hydrogen, and plasma
2. this is what 90% of stars in the sky are; they fall out of balance when all the fuel has been used up
3. this is the starting point of a star’s birth, lasting about 100,000 years; mainly made of helium and hydrogen particles, with a relatively low temperature

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ACROSS

1. BLACK DWARF
2. BLACK HOLE
3. BLACK DWARF
4. BLACK HOLE
5. NEUTRON STAR
6. SUPERNOVA
7. WHITE DWARF
8. RED GIANT
9. SUPERGIANT
10. BLACKHOLE
STAAR Science Tutorial 27
TEK 8.7A: Earth’s Seasonal & Day-Night Cycles

TEK 8.7A: Model and illustrate how the tilted Earth rotates on its axis, causing day and night, and revolves around the Sun causing changes in seasons.

The Earth spins, or rotates, on its axis once a day. This is the cause of the day—night cycle on Earth. In fact, the Earth’s counter-clockwise rotation, not any motion of the Sun, is what makes the Sun seem to rise in the East and set in the West.

The Earth orbits, or revolves, around the Sun once in a year (365.25 days), also in a counter-clockwise direction, as viewed from over the North Pole. The shape of that orbit is almost a perfect circle, but is slightly “elliptical” (oval) in shape. The Earth is slightly closer to the Sun (147 million km) on about January 3rd each year, and slightly further away from the Sun (152 million km) on about July 4th each year. This 3% difference in the Earth to Sun distance during the year does NOT make any real difference in the temperature of our seasons.

The real cause of the seasons is the tilt of the Earth’s axis, about 23.5 degrees. If the Earth’s axis was not tilted, there would be no seasons on Earth—every day would be about the same temperature in any one place. Without tilt, every day and every place on Earth (except the poles) would have exactly 12 hours of daylight and 12 hours of night. It is the tilt that causes seasonal differences in the length of night and daylight—longer nights in winter and longer days in summer. It is the tilt that causes the Sun to be high in the sky in summer and low in the sky in winter. It is the combination of longer daylight hours and more direct sunlight that causes the heat of summer, and the combination of shorter daylight hours and less direct sunlight that causes the cold of winter.

The angle of the Earth’s tilt does not change during the year. The Earth’s North Pole axis always points to Polaris, the North Star. But the hemisphere of Earth that faces the Sun more directly DOES change during the year, as the Earth orbits around the Sun. On one day a year (the summer solstice, June 21st), the northern hemisphere is tilted
directly towards the Sun, and the Sun is directly overhead at the Tropic of Cancer, 23.5 degrees north latitude. Six months later (on the winter solstice, December 21\textsuperscript{st}), the northern hemisphere is tilted directly away from the Sun, and the Sun is directly overhead at the Tropic of Capricorn, 23.5 degrees south latitude. On the two days halfway between those dates, both hemispheres face the Sun equally, the Sun is directly over the equator, and the length of day and night everywhere on Earth is exactly 12 hours each. These are called the spring (or “vernal”) equinox (on March 21\textsuperscript{st} in the northern hemisphere) and the fall (or “autumnal”) equinox (on September 21\textsuperscript{st}).

The seasons in the north and south hemispheres are the opposite of one another. In January, when it is winter in the northern hemisphere, it is summer in the summer hemisphere. In April, when it is spring in the northern hemisphere, it is fall in the southern hemisphere. In July, when it is summer in the northern hemisphere, it is winter in the southern hemisphere. In October, when it is fall in the northern hemisphere, it is spring in the southern hemisphere. Likewise, summer solstice in the northern hemisphere is the winter solstice in the southern hemisphere.

Between the Arctic Circle (66.5 degrees north latitude) and North Pole, and the Antarctic Circle (66.5 degrees south latitude) and South Pole, the apparent movement of the Sun across the sky daily and seasonally is different from the rest of Earth. At each pole, the Sun rises on the spring equinox and sets six months later on the fall equinox. Each 24 hour day during the summer, the Sun completely circles the horizon. At the Arctic or Antarctic Circles, the Sun does not set at all on one day, the summer solstice. In other words, on the summer solstice there is 24 hours of daylight and no night. Between 66.5 degrees latitude and the pole, the number of 24 hours days without a sunset increases as one moves towards the pole. In winter, the opposite occurs, with one or more 24 hour days with no sunrise, and 24 hours of darkness.

The greatest seasonal variation in daylight and night hours occurs at the North Pole and South Pole, and the lowest seasonal variation in daylight and night hours occurs in the tropics, between the Tropic of Cancer and Tropic of Capricorn, including the equator. In the tropics, the longest daylight period is 13 hours and shortest is 11 hours. In Dallas, the longest daylight period is about 14.5 hours and the shortest 9.5 hours. In southern Alaska, the longest daylight period is 19 hours, and shortest 5 hours.

The diagram on the next page shows an angled view down on the Earth’s orbit, with the Sun in the center. (The shape of the orbit is not really this elliptical (oval)—the low angle of view needed to show the tilt in each season just makes it seem elliptical.) A close-up of the Earth in each position shows the latitude where the Sun’s light is directly overhead. (A side view of Earth at the two equinox positions is used to show the angle of sunlight falling on Earth.) The solstice or equinox at each location is noted, as well as the season starting at that position and date.
Practice Questions

1. The day and night cycle on Earth is caused by the Earth’s ___SPIN___ or ___ROTATION___ on its axis.

2. The yearly cycle of seasons on Earth are caused by the ___TILT___ of the Earth’s axis and the ___ORBIT___ or ___EVOLUTION___ of the Earth around the Sun.

3. On January 3rd of each year, the Earth is ___CLOSEST___ (closest / farthest) from the Sun, ___147___ million kilometers.

4. On July 4th of each year, the Earth is ___FARDEST___ (closest / farthest) from the Sun, ___152___ million kilometers.

5. The varying distance from the Sun to the Earth ___IS NOT___ (is / is not) the reason for the seasons.

6. On about December 21st, the ___SOUTHERN___ hemisphere is tilted directly towards the Sun, and it is their ___SUMMER___ solstice.

7. On about December 21st, the ___NORTHERN___ hemisphere is tilted directly away from the Sun, and it is their ___WINTER___ solstice.

8. On about December 21st, the Sun is directly overhead at the Tropic of ___CAPRICORN___, 23.5 degrees ___SOUTH___ latitude.

9. On about March 21st, the Sun is directly overhead at the ___EQUATOR___, 0 degrees latitude, and it is the ___VERNAL/SPRING___ equinox in the northern hemisphere and the ___AUTUMNAL/FALL___ equinox in the southern hemisphere. On this day, there are ___12___ hours of daylight and ___12___ hours of night everywhere on Earth.

10. On about June 21st, the ___NORTHERN___ hemisphere is tilted directly towards the Sun, and it is their ___SUMMER___ solstice.

11. On about June 21st, the ___SOUTHERN___ hemisphere is tilted directly away from the Sun, and it is their ___WINTER___ solstice.

12. On about June 21st, the Sun is directly overhead at the Tropic of ___CANCER___, 23.5 degrees ___NORTH___ latitude.

13. On about September 21st, the Sun is directly overhead at the ___EQUATOR___, 0 degrees latitude, and it is the ___AUTUMNAL/FALL___ equinox in the northern hemisphere and the ___VERNAL/SPRING___ equinox in the southern hemisphere. On
this day, there are 12 hours of daylight and 12 hours of night everywhere on Earth.

14. The Sun is highest in the sky during the **Summer** season, and lowest in the sky during the **Winter** season.

15. The number of daylight hours is the greatest during the **Summer** season, and the lowest during the **Winter** season.

16. The greatest seasonal variation in daylight and night hours occurs at the **North Pole** and **South Pole**, and the lowest seasonal variation in daylight and night hours occurs at the **Equator**.

17. In the diagram below, label the position of Earth at the start of each season for each hemisphere, in the blanks provided. (NH = northern hemisphere; SH = southern hemisphere) Also label with arrows the direction of Earth’s spin (rotation) and orbit (revolution). Note that this diagram has a different viewpoint than the one in the explanatory text above—it is shown from the opposite side, reversing the direction of the Earth’s tilt.

![Diagram](image)


![Diagram](image)