

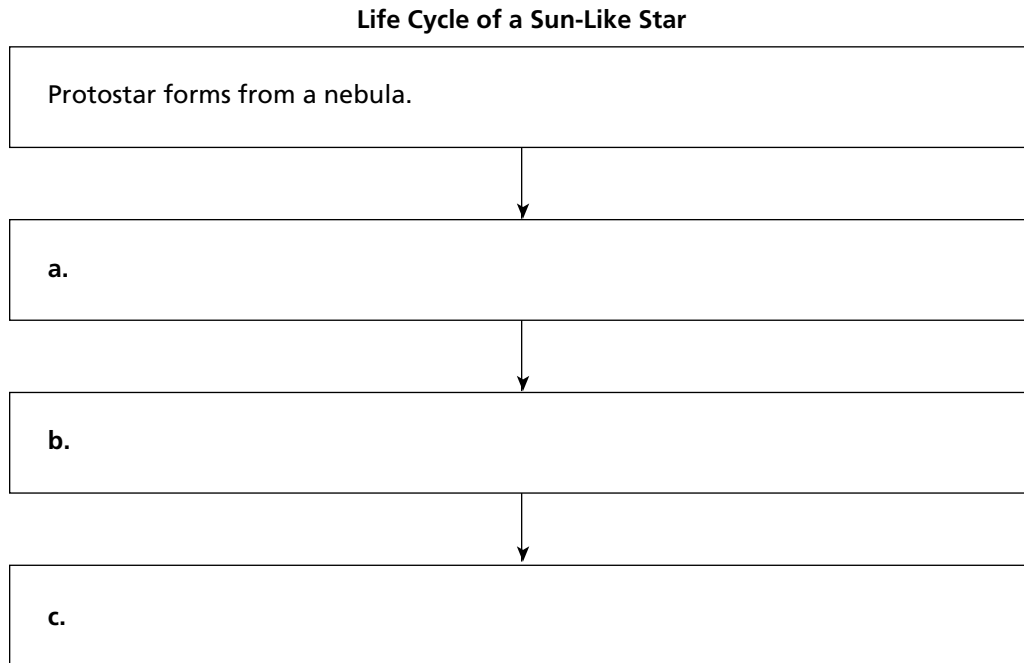
Stars, Galaxies, and the Universe ▪ *Guided Reading and Study*

Lives of Stars

This section explains how the life of a star begins. It also explains what determines how long a star lives and what happens when a star runs out of fuel.

Use Target Reading Skills

As you read about the stages in the life of a star, make a flowchart that shows the stages in the life of a low-mass star like the sun. The first step is done for you.



The Lives of Stars

1. Is the following sentence true or false? All stars begin their lives as parts of nebulas. _____
2. A large amount of gas and dust spread out in an immense volume is called a(n) _____.
3. A contracting cloud of gas and dust with enough mass to form a star is called a(n) _____.
4. Describe how a star is born.

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5. Circle the letter of the factor that determines how long a star lives.
 - a. its mass
 - b. its brightness
 - c. its volume
 - d. its temperature

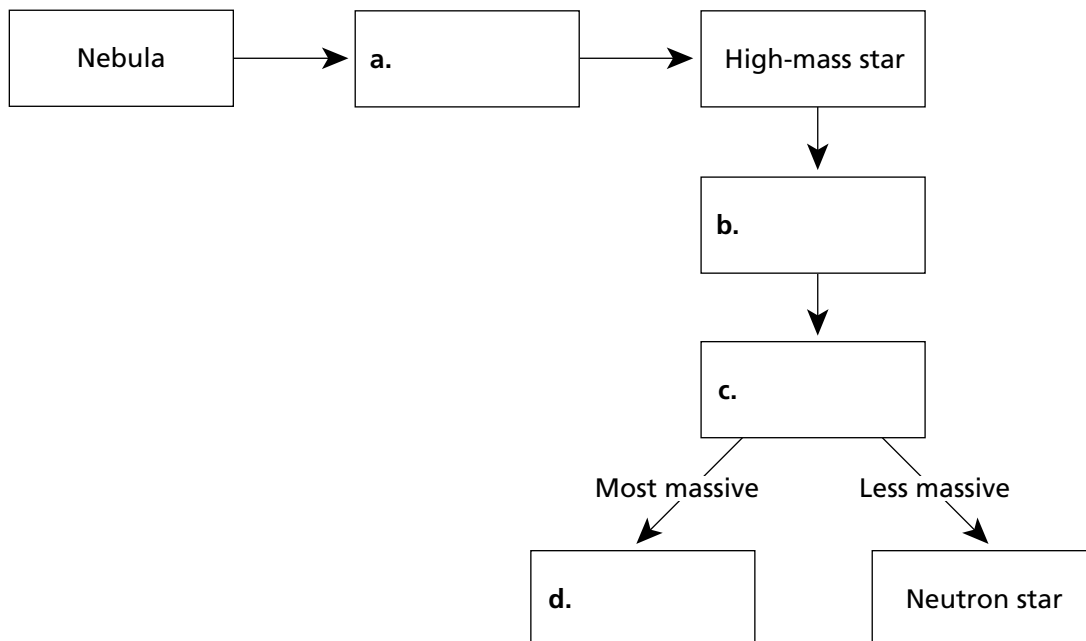
6. Is the following sentence true or false? Stars with more mass last longer than stars with less mass. _____

Deaths of Stars

Match each stage of a star with its definition.

Stage of a Star	Definition
___ 7. White dwarf	a. The small, dense remains of a high-mass star that is called a pulsar when it spins
___ 8. Planetary nebula	b. Explosion of a high-mass star
___ 9. Supernova	c. An object whose gravity is so strong nothing can escape
___ 10. Neutron star	d. A cloud of gas formed from the expanding outer layer of a red giant
___ 11. Black hole	e. The cooled core of a star that has run out of fuel

12. Complete the flowchart to show the stages in the life of a high-mass star.



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Lives of Stars *(continued)*

e. What determines which stage occurs after a supernova?

f. How do all stars begin?

g. What is the relationship between mass and the end stages of stars?

13. How do astronomers think the sun may have begun?

14. Since no form of radiation can ever get out of a black hole, how can astronomers detect where black holes are?

Stars, Galaxies, and the Universe ▪ *Section Summary*

Lives of Stars

Key Concepts

- How does a star form?
- What determines how long a star will live?
- What happens to a star when it runs out of fuel?

Astronomers can't watch a single star for billions of years so they study many stars in different stages of the stars' life cycles to see how they differ from one another. Each star is born, goes through its life cycle, and dies.

A **nebula** is a large cloud of gas and dust spread out in an immense volume. 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 contracting gas and dust from a nebula become so dense and hot that nuclear fusion starts.**

How long a star lives depends on its mass. Small-mass stars use their fuel more slowly than large-mass stars, so they have much longer lives.

When a star begins to run out of hydrogen fuel, the star becomes a red giant or supergiant. **When a star runs out of fuel, it becomes a white dwarf, a neutron star, or a black hole.**

When small-mass or medium-mass stars use up their fuel, their outer layers expand. At this stage they are called red giants. Eventually, 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**.

A dying giant or supergiant 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. They are even smaller and denser than white dwarfs.

In 1967, Jocelyn Bell found an object in space that appeared to give off regular pulses of radio waves. Astronomers soon discovered that the source of the radio waves was a rapidly spinning neutron star. Spinning neutron stars are called **pulsars**, short for pulsating radio sources.

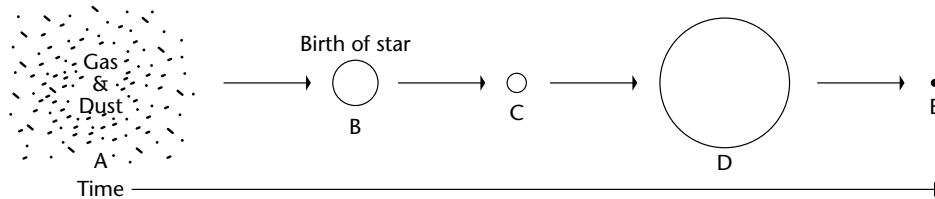
The most massive stars become **black holes** when they die. After a large-mass star explodes, a large amount of mass may remain. The gravity of the mass is so strong that gas is pulled inward, pulling more gas into a smaller and smaller space. Eventually, the gravity becomes so strong that nothing can escape, not even light.

Stars, Galaxies, and the Universe ▪ *Review and Reinforce*

Lives of Stars

Understanding Main Ideas

Fill in each blank with the correct letter from the diagram.



- ___ 1. Red giant or supergiant
- ___ 2. Where fusion begins
- ___ 3. Part of a nebula
- ___ 4. White dwarf, neutron star, or black hole
- ___ 5. The stage the sun is in

Fill in the blank.

- 6. How long a star lives and what it becomes at the end of its life depend primarily on its _____.

Building Vocabulary

From the list below, choose the term that best matches each phrase.

- | | |
|--|---|
| <ul style="list-style-type: none"> ___ 7. pulsar ___ 8. white dwarf ___ 9. nebula ___ 10. protostar ___ 11. supernova ___ 12. neutron star ___ 13. black hole | <ul style="list-style-type: none"> a. exerts such a strong gravitational pull that no electromagnetic radiation can escape b. a large cloud of gas or dust in space c. what a medium-mass star becomes at the end of its life d. the earliest stage of a star's life e. appears to emit pulses of radio waves f. formed from the leftover material after a giant star explodes; may contain as much as three times the mass of the sun g. an explosion that occurs at the end of a giant star's life |
|--|---|

Stars, Galaxies, and the Universe

Stars, Galaxies, and the Universe ▪ *Enrich*

Planetary Nebulas

Medium-sized stars, such as the sun, eventually consume all of the nuclear fuel available. The core shrinks and becomes hotter, while the surface expands. The star becomes a red giant. In the very last stage of its life as a star, the core collapses into a white dwarf, while the remaining hydrogen drifts away into a shell of gas called a planetary nebula. Planetary nebulas are considered by many astronomers and photographers to be the most beautiful astronomical objects that can be seen with a telescope. They are called planetary nebulas because the astronomers who first saw them thought they resembled planets in size and color. One of the most attractive planetary nebulas is found in the constellation Lyra. It is called the Ring Nebula.

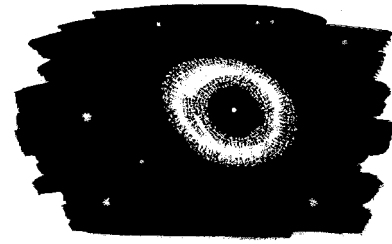
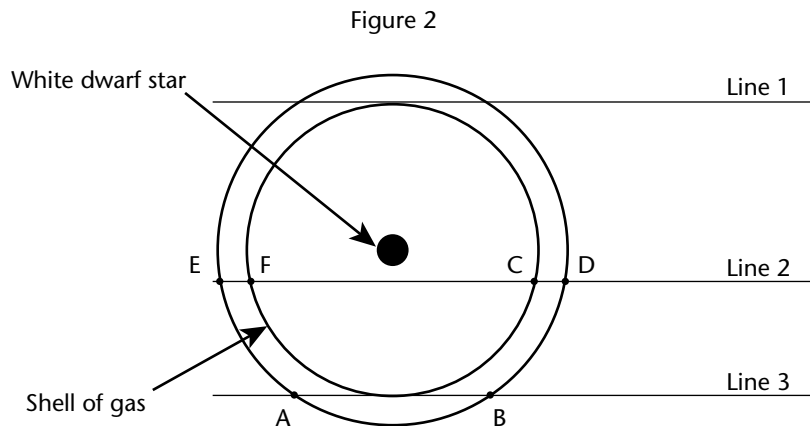


Figure 1

The gas surrounds the white dwarf in a three-dimensional sphere. Why does a three-dimensional spherical shell of gas appear to be a two-dimensional ring? Figure 2 shows the cross section of a shell of gas around a white dwarf. If you look at the shell from the right along line 1 or line 3, it appears bright. But if you look at the shell along line 2, it is less bright.



Examine the figures and answer the questions below on a separate sheet of paper.

1. How far is it from A to B in millimeters?
2. How far is it from C to D in millimeters, plus from E to F?
3. Are you looking through more of the shell along line 2 or along line 3?
4. Would the shell appear to be thicker and brighter along line 2 or along line 3?
5. Why does the Ring Nebula appear to us as a ring?