Name _____ Date _____ Class _____

Highlighted Key

Telescopes (pp. 598–604)

This section describes electromagnetic radiation. It also explains how different types of telescopes work and where they are located.

Use Target Reading Skills

The first column in the chart lists key terms in this section. Write what you know about the key term in the second column. As you read, write a definition of the key term in your own words in the third column. Some examples are done for you. Connecting what you already know about key terms helps you to remember them.

Key Term	What You Know	Definition
Telescope	You use it to see distant objects better.	Device that makes objects far away seem closer
Electromagnetic radiation	You can see only some types of it.	Energy in the form of waves that moves through space
Visible light	Check students' definitions for accuracy.	
Wavelength		
Spectrum		
Optical telescope		
Refracting telescope		
Convex lens		
Reflecting telescope		
Radio telescope		
Observatory		

Telescopes *(continued)*

Electromagnetic Radiation (p. 599)

1. What is electromagnetic radiation?
Electromagnetic radiation is energy that can travel through space in the form of waves.

2. The light you see with your eyes is called visible light.

3. The distance between the crest of one wave and the crest of the next wave is called a(n) wavelength.

4. A range of light of different colors and different wavelengths is called a(n) spectrum.

5. What colors form the spectrum of visible light?
red, orange, yellow, green, blue, and violet

6. What wavelengths are included in the electromagnetic spectrum?
It includes radio waves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays.

Types of Telescopes (pp. 600–601)

7. What do telescopes collect and focus?
They collect and focus electromagnetic radiation.

8. What is a convex lens?
A convex lens is a piece of transparent glass, curved so that the middle is thicker than the edges.

9. Complete the table to compare and contrast different types of telescopes.

Telescopes	
Type	**Description**
Refracting telescope	**a.** uses convex lenses to gather and focus light
Reflecting telescope	**b.** uses a curved mirror to collect and focus light
Radio telescope	**c.** has a curved, reflecting surface that focuses radio waves

d. How is a radio telescope different from both a refracting and a reflecting telescope?
A radio telescope detects electromagnetic radiation that is not visible to humans.

e. How is a radio telescope similar to both a refracting and a reflecting telescope?
A radio telescope focuses radio waves the way refracting and reflecting telescopes focus visible light waves.

10. Which telescope uses convex lenses? refracting telescope

11. The largest visible light telescopes are now all reflecting telescopes.

Observatories (pp. 602–604)

12. A building that contains one or more telescopes is called a(n) observatory.

13. Why have astronomers built the largest optical telescopes on the tops of mountains?
Earth's atmosphere makes objects in space look blurry. The sky viewed from some mountaintops is clearer and is not brightened by city lights.

14. Why have astronomers placed telescopes in space?
Some telescopes in space can detect ultraviolet radiation, X-rays, and gamma rays that are blocked by Earth's atmosphere. Others can detect visible light or infrared radiation that is partially interfered with by Earth's atmosphere.

15. Why can the Hubble Space Telescope make very detailed images in visible light?
It makes such detailed images because it is large and is located above Earth's atmosphere.

Name _____ Date _____ Class _____

Characteristics of Stars (pp. 606–613)

This section explains how astronomers measure distances to stars. It also describes how stars are classified.

Use Target Reading Skills

As you read about stars, stop and write what you know about that topic. As you read the section, write what you learn. An example is done for you.

What You Know
1. Stars are bright and hot.
2. Distances between stars are often measured in light-years.
3. The sun is a yellow star.

What You Learned
1. Stars are classified based on color, temperature, size, composition, and brightness.
2. Light travels through space a distance of 9.5 million million kilometers in one year.
3. The sun has a surface temperature of about 5,800°C.

Introduction (p. 606)

1. Imaginary patterns of stars are called constellations.

Classifying Stars (pp. 607–608)

2. What are five characteristics used to classify stars?

a. color b. temperature

c. size d. composition

e. brightness

3. What reveals a star's temperature?

Its color reveals its surface temperature.

4. Circle the letter of what is revealed by the red color of the supergiant star called Betelgeuse.
   a. It is an extremely hot star.
   b. It is in a constellation.
   c. It is far away.
   (d.) It is a fairly cool star.

5. Stars that are much larger than the sun are called giant stars or supergiant stars.

6. Is the following sentence true or false? Each element has a unique set of lines on a spectrum. true

7. How can astronomers infer which elements are found in a star?
   They can compare a star's spectrum with the known spectrums of different elements.

8. What does a spectrograph do?
   A spectrograph breaks the light from an object into colors and makes an image of the resulting spectrum.

9. What is the chemical composition of most stars?
   about 73 percent hydrogen, 25 percent helium, and 2 percent other elements by mass

Brightness of Stars (pp. 608–609)

10. The amount of light a star gives off is called its brightness.

11. Why does Rigel shine as brightly as Betelgeuse, even though Rigel is much smaller than Betelgeuse?
    Rigel is very hot, so each square meter of its photosphere gives off a lot of light. Betelgeuse is a fairly cool star, so each square meter of its photosphere doesn't give off much light.

Characteristics of Stars *(continued)*

12. What two factors determine how bright a star looks from Earth?

    a. how far the star is from Earth

    b. how bright the star actually is

13. Complete the table about the measurement of a star's brightness.

Brightness of Stars	
Measurement of Brightness	**Definition**
Apparent brightness	**a.** the brightness of a star as seen from Earth
Absolute brightness	**b.** the brightness a star would have if it were a standard distance from Earth

Star X is closer to Earth than Star Y. Star X appears brighter than Star Y. Use the table to answer the following questions.

c. Compare Star X with Star Y using the term *apparent brightness*.

Star X has a greater apparent brightness than Star Y.

d. Can you compare the absolute brightness of Star X with Star Y? Why or why not?

You cannot compare the absolute brightness because you do not know how much farther Star Y is from Earth than Star X. Star Y could be brighter or not as bright as Star X if both were to be seen from the same distance.

14. Is the following sentence true or false? The closer a star is to Earth, the brighter it appears. true

15. What two things must an astronomer find out in order to calculate a star's absolute brightness?

    a. the star's apparent brightness

    b. the star's distance from Earth

Measuring Distances to Stars (pp. 610–611)

16. Is the following sentence true or false? In space, light travels at a speed of 300,000 kilometers per ~~year~~ second. false

17. What is a light-year?

    A light-year is the distance light travels through space in one year.

18. A light-year equals about 9.5 million million kilometers.

19. Is the following sentence true or false? The light-year is a unit of ~~time~~ distance. ~~false~~ true

20. What is parallax?

    Parallax is the apparent change in position of an object when you look at it from different places.

21. Astronomers use parallax to measure the distance to which of the following objects?

    a. distant stars
    b. the sun
    c. the planets
    (d.) nearby stars

22. To measure parallax shift, astronomers look at the same star at two different times of the year, when Earth is on different sides of the sun.

The Hertzsprung-Russell Diagram (pp. 612–613)

23. The diagram that shows the relationship between the surface temperatures of stars and their absolute brightness is called the Hertzsprung-Russell diagram.

24. Look at the Hertzsprung-Russell diagram in your textbook. Write what is measured on each of the two axes of the diagram.

    a. *x*-axis (horizontal axis): surface temperature (°C) or color

    b. *y*-axis (vertical axis): absolute brightness

Characteristics of Stars *(continued)*

25. An area on the Hertzsprung-Russell diagram that runs from the upper left to the lower right and includes more than 90 percent of all stars is called the main sequence.

26. Circle the letter of each sentence that is true based on the Hertzsprung-Russell diagram in your textbook.

(a.) The sun is a main-sequence star.
b. White dwarfs are brighter than supergiants.
(c.) Rigel is hotter than Betelgeuse.
(d.) Polaris is brighter than the sun.

Lives of Stars (pp. 616–620)

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.

Life Cycle of a Sun-Like Star

Protostar forms from a nebula.

↓

a. A star is born as fusion begins.

↓

b. The star gradually runs out of fuel.

↓

c. The star becomes a red giant, then a white dwarf.

The Lives of Stars (p. 617)

1. Is the following sentence true or false? All stars begin their lives as parts of nebulas. true

2. A large amount of gas and dust spread out in an immense volume is called a(n) nebula.

3. A contracting cloud of gas and dust with enough mass to form a star is called a(n) protostar.

4. Describe how a star is born.

A star is born when the contracting gas and dust from a nebula become so dense and hot that nuclear fusion starts.

Lives of Stars *(continued)*

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

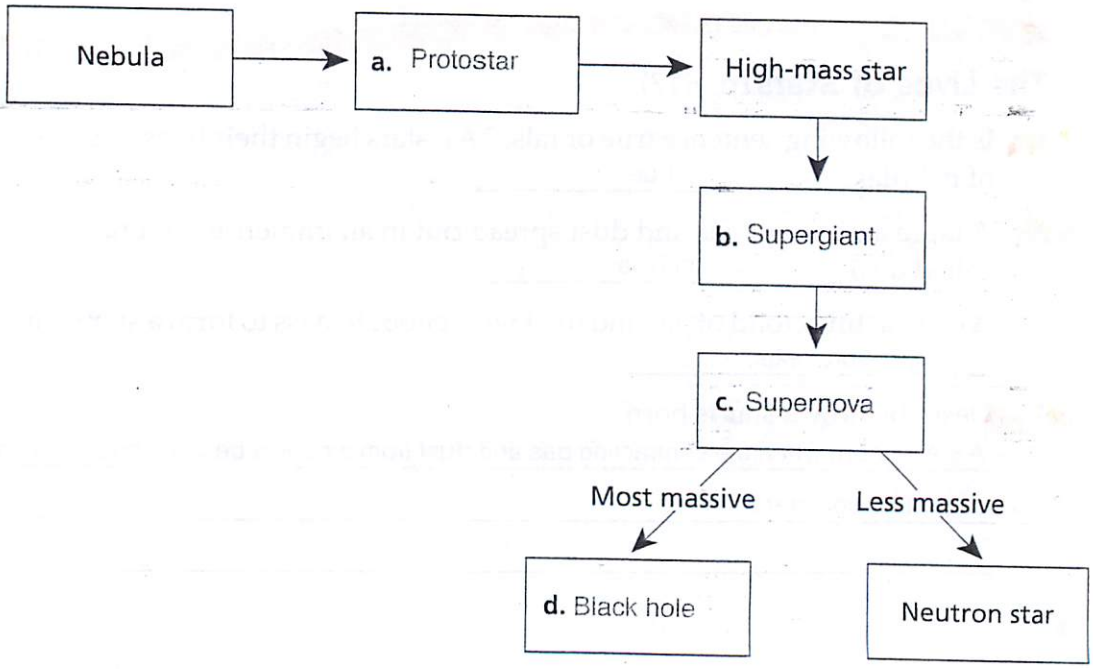
6. Is the following sentence true or false? Stars with ~~more~~ less mass last longer than stars with ~~less~~ more mass. ~~false~~ true

Deaths of Stars (pp. 618–620)

Match each stage of a star with its definition.

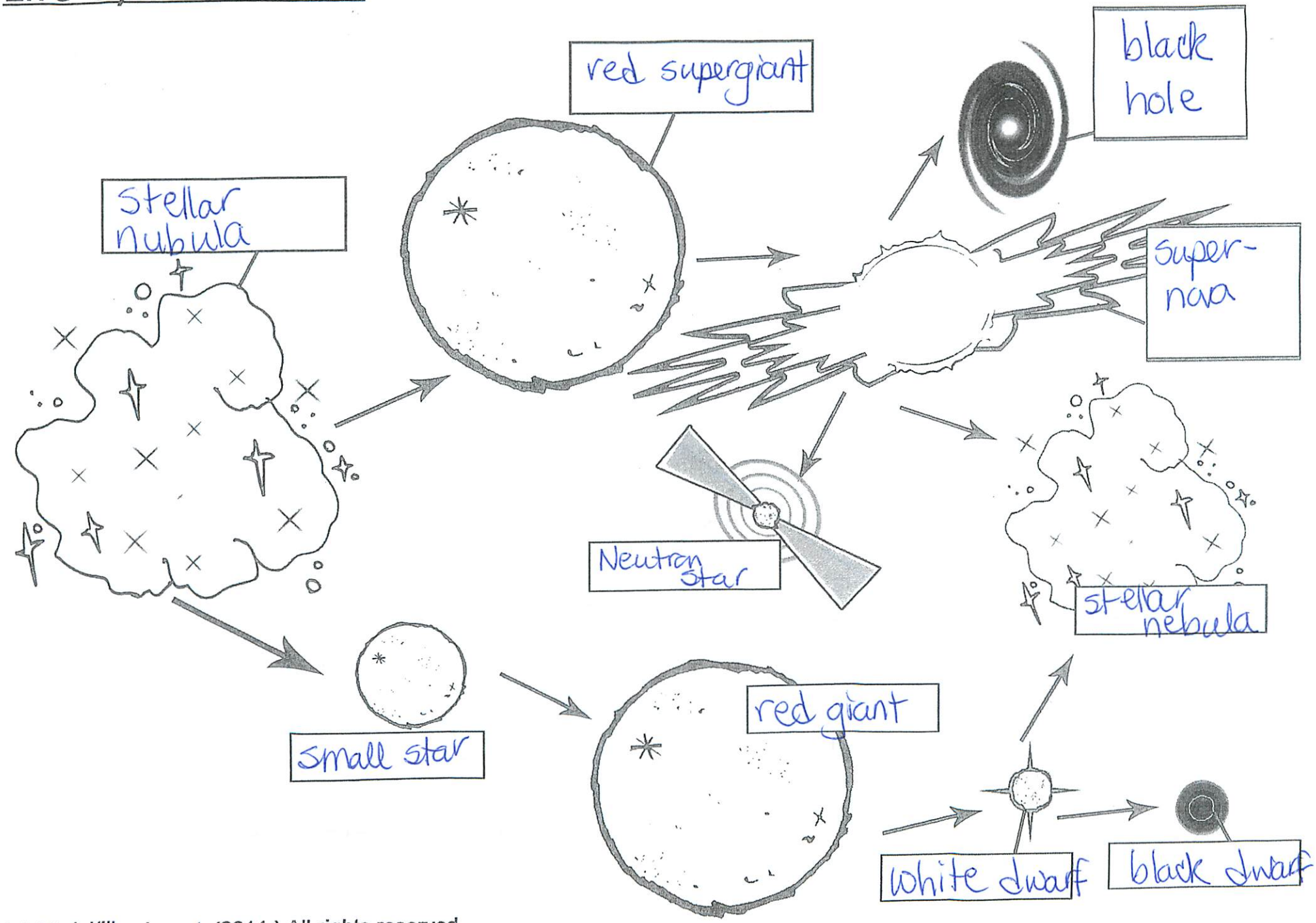
Stage of a Star		Definition
e	7. White dwarf	a. The small, dense remains of a high-mass star that is called a pulsar when it spins
d	8. Planetary nebula	b. Explosion of a high-mass star
b	9. Supernova	c. An object whose gravity is so strong nothing can escape
a	10. Neutron star	d. A cloud of gas formed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



Life Cycle of a Star

Name:_____ Date_____ Block_____



Lives of Stars *(continued)*

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 (pp. 618–620)

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

f. How do all stars begin?

_____

_____

Star Systems and Clusters (pp. 622–623)

1. What are star systems?

_____

_____

Galaxies (p. 624)

9. What is a galaxy?

_____

_____

Match the type of galaxy with its shape.

Type of Galaxy	Description of Shape
____ 10. Spiral galaxy	a. Bulge in middle and arms that spiral outward
____ 11. Elliptical galaxy	b. Does not have a regular shape
____ 12. Irregular galaxy	c. Looks like round or flattened ball

e. What determines which stage occurs after a supernova?

Stars that are the most massive become black holes. Stars that are less massive but still high-mass stars become neutron stars.

f. How do all stars begin?

They all start out as parts of nebulas that contract to form protostars.

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

Low-mass and medium-mass stars turn into red giants as they use up their fuel. They later form planetary nebulas and white dwarfs. High-mass stars turn into supergiants as they run out of fuel. They later explode as supernovas, forming either neutron stars or black holes.

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

The sun may have begun as a nebula that contained material from a supernova.

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

They can detect X-rays coming from rotating hot gas near a black hole. They can detect the presence of a black hole from the effect of its gravity on a nearby star.

Star Systems and Galaxies (pp. 621–627)

This section explains what a star system is, describes the three major types of galaxies, and describes the scale of the universe.

Use Target Reading Skills

The first column in the chart lists key terms in this section. As you read the section, write a definition of the key term in your own words in the second column. Underline the most important feature or function in each definition. An example is done for you.

Key Term	Definition
Binary star	Star system with two stars.
Eclipsing binary	Check students' definitions for accuracy.
Open cluster	
Globular cluster	
Galaxy	
Spiral galaxy	
Elliptical galaxy	
Irregular galaxy	
Quasar	
Universe	
Scientific notation	

Star Systems and Clusters (pp. 622–623)

1. What are star systems?

They are groups of two or more stars.

2. Star systems with two stars are called double stars or binary stars.

3. How can astronomers tell whether there is an unseen second star in a system?

(a.) They observe the effects of its gravity on the brighter star.
b. They measure the parallax of the second star.
c. They send a probe to the second star.
(d.) They observe regular changes in the brightness of the star system.

4. A star system in which one star periodically blocks the light from another star is a(n) eclipsing binary.

5. How did astronomers first discover a planet revolving around another star?

They observed the effects of the planet's gravity on the star.

6. Why have most new planets discovered around other stars been very large?

Any small planets would be hard to detect because their gravitational effect on their star would be quite small.

7. A grouping of stars that has a loose, disorganized appearance and contains no more than a few thousand stars is called a(n) open cluster.

8. A large grouping of stars that contains mostly older stars is called a(n) globular cluster.

Galaxies (p. 624)

9. What is a galaxy?

a huge group of single stars, star systems, star clusters, dust, and gas bound together by gravity

Match the type of galaxy with its shape.

Type of Galaxy	Description of Shape
a 10. Spiral galaxy	a. Bulge in middle and arms that spiral outward
c 11. Elliptical galaxy	b. Does not have a regular shape
b 12. Irregular galaxy	c. Looks like round or flattened ball

Star Systems and Galaxies *(continued)*

13. Circle the letter of each sentence that is true about galaxies.
    a. Elliptical galaxies contain only new stars.
    b. Irregular galaxies usually have many bright, young stars.
    c. In spiral galaxies, most new stars form in the spiral arms.
    d. Quasars have huge bar-shaped regions of stars that pass through their center.

14. A young galaxy with a giant black hole at the center is a(n) quasar.

The Milky Way (p. 625)

15. The galaxy in which our solar system is located is called the Milky Way.

16. What type of galaxy is the Milky Way?
The Milky Way is usually thought of as a standard spiral galaxy. However, some evidence suggests that the Milky Way may be a barred-spiral galaxy.

The Scale of the Universe (pp. 626–627)

17. Why do astronomers often use scientific notation?
The numbers they use are often very large or very small.

18. Suppose a star is about 38,000,000,000,000 kilometers away from Earth. How do you write this number in scientific notation?
3.8×10^{13} kilometers

19. What is the Local Group?
The Local Group is a cluster of about 50 galaxies to which the Milky Way belongs.

20. How large is the observable universe? about 10^{10} light-years, or 10^{26} meters

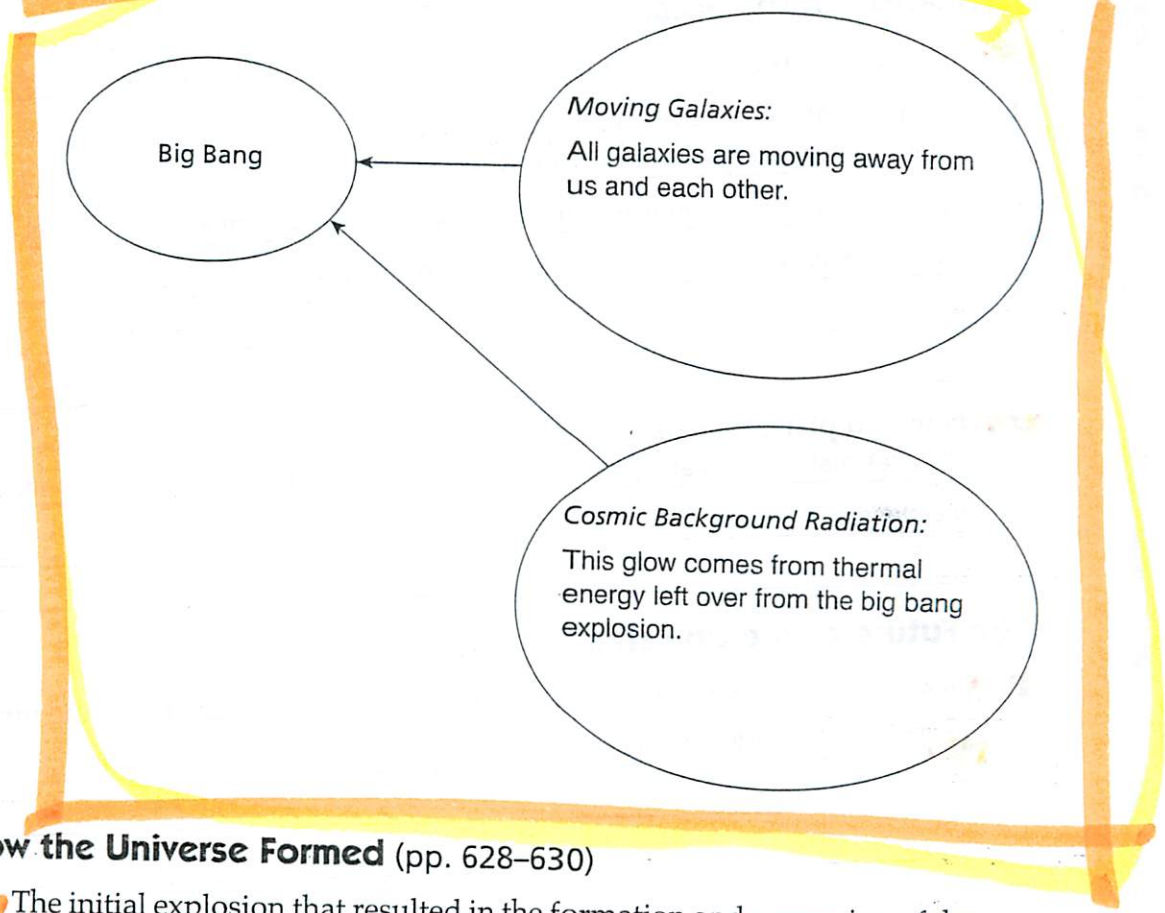
Name _____ Date _____ Class _____

The Expanding Universe (pp. 628–633)

This section explains how astronomers think the universe and the solar system formed.

Use Target Reading Skills

As you read about the evidence that supports the big bang theory, complete the graphic organizer.



How the Universe Formed (pp. 628–630)

1. The initial explosion that resulted in the formation and expansion of the universe is called the big bang.

2. When did the big bang occur?
It occurred about 13.7 billion years ago.

3. Is the following sentence true or false? The farther away a galaxy is from us, the faster it is moving away from us. true

4. How is the universe like rising raisin bread dough?
The galaxies in the universe, like the raisins in the rising dough, are moving away from one another. In the universe, it is space that is expanding, like the dough between the raisins.

The Expanding Universe *(continued)*

5. Radiation left over from the big bang is called cosmic background radiation.

6. How can astronomers infer approximately how long the universe has been expanding?
They know approximately how fast the universe is expanding now.

Formation of the Solar System (p. 631)

7. About how long ago did our solar system form? five billion years ago

8. What events led to the birth of the sun?
A large cloud of dust and gas collapsed. Gravity pulled the cloud together and, as it shrank, it spun faster and faster, forming a rotating disk. Gravity pulled most of the gas into the center, where the gas became hot and dense enough for nuclear fusion to begin.

9. How did planetesimals form planets?
Planetesimals collided and grew larger by sticking together, eventually combining to form the planets.

The Future of the Universe (pp. 632–633)

10. Describe two possibilities of what will happen to the universe in the future.

a. The universe will continue to expand as it is doing now. Eventually all the stars will run out of fuel.

b. The force of gravity will begin to pull the galaxies back together. The result will be a reverse big bang. All of the matter in the universe will eventually be crushed into an enormous black hole.

11. Which possibility in #10 is more likely? Explain why.
a. is more likely because astronomers have observed that the expansion of the universe appears to be accelerating. They infer that a force called dark energy is causing this acceleration.