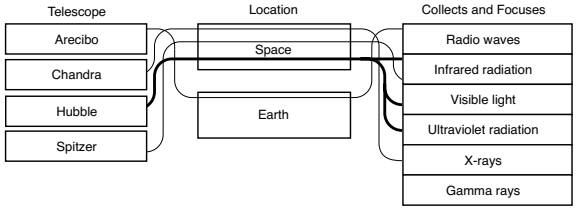
Telescopes
Guided Reading and Study

Use Target Reading Skills Check student definitions for accuracy.

1. Electromagnetic radiation is energy that can travel through space in the form of waves.
2. visible light
3. wavelength
4. spectrum
5. red, orange, yellow, green, blue, and violet
6. It includes radio waves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays.
7. They collect and focus electromagnetic radiation.
8. A convex lens is a piece of transparent glass, curved so that the middle is thicker than the edges.
9. **a.** Uses convex lenses to gather and focus light **b.** Uses a curved mirror to collect and focus light **c.** Has a curved, reflecting surface that focuses radio waves **d.** A radio telescope detects electromagnetic radiation that is not visible to humans. **e.** A radio telescope focuses radio waves the way refracting and reflecting telescopes focus visible light waves.
10. refracting telescope
11. reflecting telescopes
12. observatory
13. 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. 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. It makes such detailed images because it is large and is located above Earth's atmosphere.

Telescopes
Review and Reinforce



1. energy that can travel through space in the form of waves
2. d
3. c
4. a
5. f
6. b
7. e

Telescopes
Enrich

1. Gamma radiation should give the highest resolution image because it has the shortest wavelength.
2. Answers may vary. Possible answer: Space telescopes are expensive to build and launch. A large telescope, with high resolution, would be especially expensive to launch. A telescope in space that breaks is harder to fix than one that is on the ground.
3. Radio waves could be observed more cheaply and easily from ground-based radio telescopes. The low-resolution images are acceptable because the astronomers are looking at broad areas of the sky, not tiny details.
4. Infrared radiation, because this kind of radiation can pass through the clouds of gas and dust in space and because its wavelength is short enough to create a higher resolution image.

Design and Build a Telescope
Technology Lab

For answers, see the Teacher's Edition.

Characteristics of Stars
Guided Reading and Study

Use Target Reading Skills This is one possible way to complete the graphic organizer. Accept all logical answers.

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.

1. constellations
2. **a.** color **b.** temperature **c.** size **d.** composition **e.** brightness
3. Its color reveals its surface temperature.

4. d
5. giant stars or supergiant stars
6. true
7. They can compare a star's spectrum with the known spectrums of different elements.
8. A spectrograph breaks the light from an object into colors and makes an image of the resulting spectrum.
9. about 73 percent hydrogen, 25 percent helium, and 2 percent other elements by mass
10. brightness
11. 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.
12. **a.** How far the star is from Earth **b.** How bright the star actually is
13. **a.** The brightness of a star as seen from Earth
b. The brightness a star would have if it were at a standard distance from Earth
c. Star X has a greater apparent brightness than Star Y.
d. 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. true
15. **a.** The star's apparent brightness **b.** The star's distance from Earth
16. false
17. A light-year is the distance that light travels through space in one year.
18. 9.5 million million
19. false
20. Parallax is the apparent change in position of an object when you look at it from different places.
21. d
22. sun
23. Hertzsprung-Russell diagram
24. **a.** Surface temperature (°C) or color
b. Absolute brightness
25. main sequence
26. a, c, d

Characteristics of Stars Review and Reinforce

1. A
2. B
3. Their distance from Earth
4. Astronomers use parallax to measure the distance to nearby stars. They measure how much the star appears to move against a background of stars that are much farther away.
5. The main characteristics used to classify stars are size, temperature, brightness, color, and composition.
6. The sun is an average brightness, medium-sized star, with a surface temperature of about 5,800 degrees Celsius. It is composed of about 73 percent hydrogen, 25 percent helium, and 2 percent other elements by mass. The sun appears yellow.
7. absolute brightness
8. spectrograph
9. light-year
10. main sequence
11. Hertzsprung-Russell diagram
12. Parallax
13. constellation
14. apparent brightness

Characteristics of Stars Enrich

1. The difference in magnitude is 1. Procyon is about 2.5 times brighter than Regulus.
2. The magnitude of Venus is 2 less than that of Mars, so Venus is about 2.5 × 2.5, or about 6.3 times brighter than Mars.
3. The difference in magnitude between the dimmest star that can be seen with the naked eye and the dimmest one that can be seen with binoculars is 4. This means that the dimmest naked-eye star is about 2.5 × 2.5 × 2.5 × 2.5 = about 39 times brighter than the dimmest binocular star.

How Far Is That Star? Skills Lab

For answers, see the Teacher's Edition.

Lives of Stars Guided Reading and Study

Use Target Reading Skills
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, and then a black dwarf.
1. true
2. nebula
3. protostar
4. A star is born when the contracting gas and dust from a nebula become so dense and hot that nuclear fusion starts.
5. a
6. false
7. e

8. d
9. b
10. a
11. c
12. **a.** Protostar **b.** Supergiant **c.** Supernova **d.** Black Hole **e.** Stars that are the most massive become black holes. Stars that are less massive but still high-mass stars become neutron stars. **f.** They all start out as a part of nebulas that contract to form protostars. **g.** Low-mass and medium-mass stars turn into red giants as they use up their fuel. They later form planetary nebulas, white dwarfs, and black 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. The sun may have begun as a nebula that contained material from a supernova.
14. 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.

Lives of Stars
Review and Reinforce

1. D
2. B
3. A
4. E
5. C
6. mass
7. e
8. c
9. b
10. d
11. g
12. f
13. a

Lives of Stars
Enrich

1. 26 mm
2. 8 mm (4 mm + 4 mm)
3. You are looking through more of the shell along line 3.
4. The shell would appear thicker and brighter along line 3.
5. The shell must be glowing, since it shows up as a light color. When you look through the outer part of the shell, your line of sight includes more of the glowing shell of gas than when you look nearer the center, so you see a ring.

Star Systems and Galaxies
Guided Reading and Study

Use Target Reading Skills Check student definitions for accuracy.
1. They are groups of two or more stars.
2. binary stars
3. a, d
4. eclipsing binary
5. They observed the effects of the planet's gravity on the star.
6. Any small planets would be hard to detect because their gravitational effect on their star would be quite small.
7. open cluster
8. globular cluster
9. A huge group of single stars, star systems, star clusters, dust, and gas bound together by gravity
10. a
11. c
12. b
13. b, c
14. quasar
15. Milky Way
16. 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 instead.
17. The numbers they use are often very large or very small.
18. 3.8×10^{13} kilometers
19. The Local Group is a cluster of about 50 galaxies to which the Milky Way belongs.
20. about 10^{10} light-years, or 10^{26} meters

Star Systems and Galaxies
Review and Reinforce

1. B
2. The position of the visible star might wobble slightly as the high-mass unseen star revolves around it.
3. A star system made up of two stars
4. A binary star system in which a brighter star appears to dim when the dimmer star of the pair passes in front of it
5. A star cluster with a disorganized appearance and no more than a few thousand stars
6. A large, round, densely-packed grouping of stars
7. Spiral galaxies are galaxies with spiral arms radiating out from the center. They contain lots of dust and gas.

8. Elliptical galaxies look like flattened balls. They have little dust and gas.
9. Irregular galaxies are galaxies with irregular shapes.
10. An active young galaxy with a giant black hole at its center
11. All of space and everything in it
12. A mathematical method of writing numbers using powers of ten

Star Systems and Galaxies Enrich

	Length of cycle (days)	Absolute brightness (sun = 1)	Distance (light-years)
A	**5**	**1,250**	**500**
B	**20**	**3,000**	**700**
C	**35**	**5,000**	**1,000**
D	**50**	**7,500**	**1,200**
E	**90**	**12,500**	**1,600**

Note: Since students will be using rulers to read the graph, their answers will be approximations only.

The Expanding Universe Guided Reading and Study

Use Target Reading Skills *Moving Galaxies:* All galaxies are moving away from us and from each other. *Cosmic Background Radiation:* This glow comes from thermal energy left over from the big bang explosion.
1. big bang
2. It occurred billions of years ago.
3. true
4. The galaxies in the universe, like the raisins in the rising dough, are moving away from one other. In the universe, it is space that is expanding, like the dough between the raisins.
5. cosmic background radiation
6. They know approximately how fast the universe is expanding now.
7. five billion years ago
8. A large cloud of gas and dust 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. Planetesimals collided and grew larger by sticking together, eventually combining to form the planets.
10. **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. 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.

The Expanding Universe Review and Reinforce

1. Away from Earth and from each other
2. The farther away a galaxy is, the faster it moves away from Earth.
3. Gravity slowly began to pull a solar nebula together. Most of the gas was pulled into the center of the disk, where the gas eventually became hot and dense enough for nuclear fusion to begin. The sun was born.
4. f
5. c
6. a
7. b
8. d
9. e

The Expanding Universe Enrich

	Rank
Galaxy A	1
Galaxy B	4
Galaxy C	2
Galaxy D	3

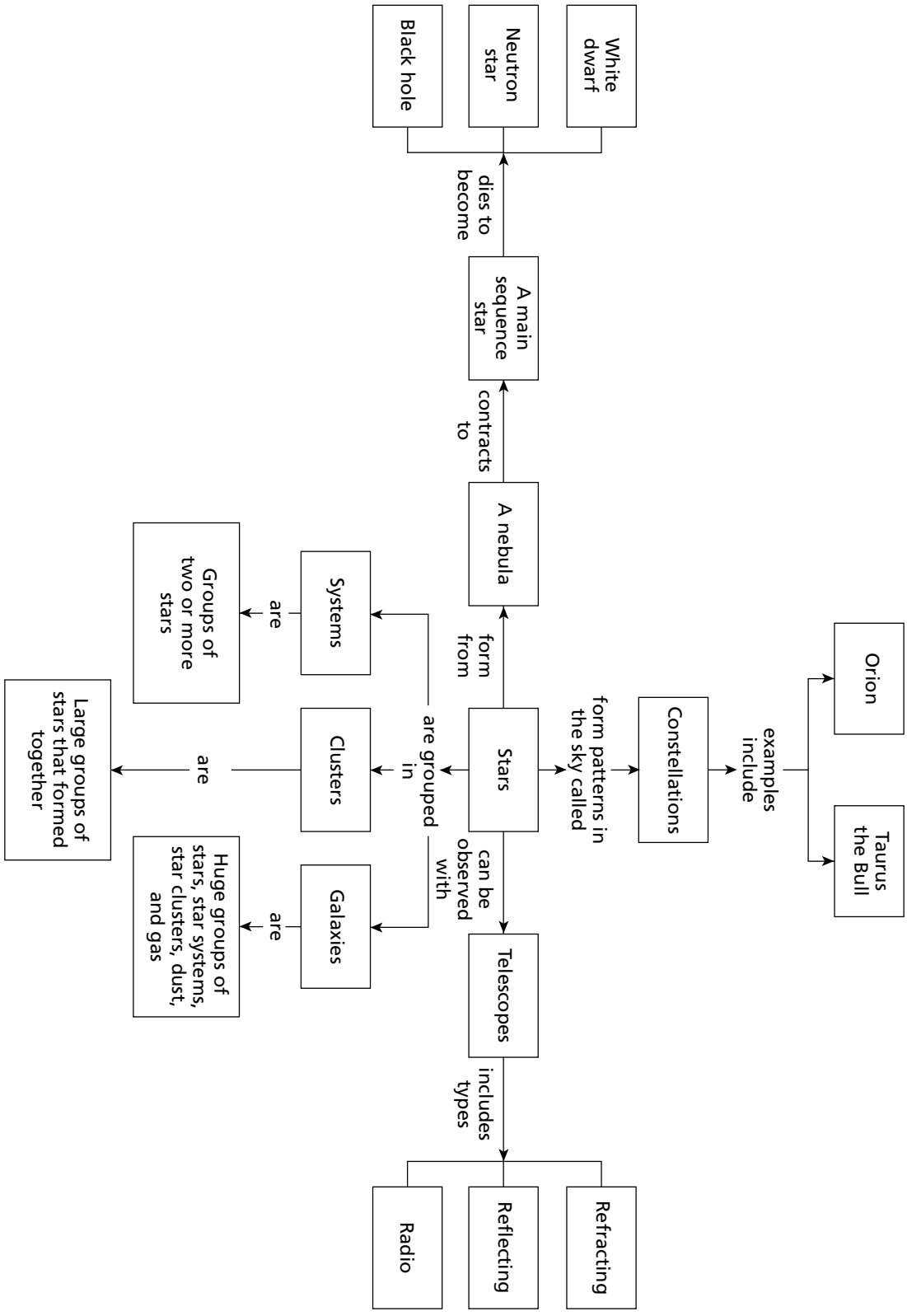
1. Galaxy B is farthest from Earth, as it has the greatest red shift.
2. No, because none of the spectrums is blue shifted.

Use Key Terms

1. protostar
2. black hole
3. spectrograph
4. universe
5. neutron star
6. big bang
7. constellation
8. supernova
9. spiral galaxy
10. observatory
11. radio telescope
12. parallax
13. quasar
Hidden Message: The sun is a star.

Connecting Concepts

This concept map is only one way to represent the main ideas and relationships in this chapter. Accept other logical answers from students.



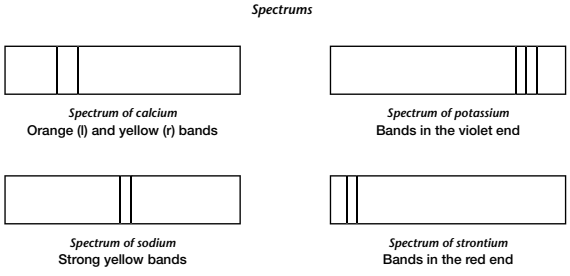
Lab Investigation

Chemical Composition and the Spectrum

Pre-Lab Discussion

1. A spectrum is a range of electromagnetic waves of different wavelengths. Each element gives off energy at a different wavelength and produces a unique set of lines on a spectrum. By studying a star's spectrum, astronomers can infer which elements are found in that star and what the star's surface temperature is.
2. No; many types of electromagnetic waves have wavelengths that cannot be detected by the human eye.

Observations



Sample Data
Unknown solution: Answers should match the spectrum of the metal in the solution supplied by the teacher.
Mixture: Answers should be a combination of the spectrums of the metals in both solutions used to make the mixture.

Analyze and Conclude

1. You must avoid contamination to get the characteristic spectrum of the particular metal being tested but of no other metals.
2. They differ in brightness, location, and color of the lines.
3. It would show how many spectral lines, from red at one end of the visible spectrum to violet at the other end.
4. Answers will vary. The unknown sample can be identified by comparing its spectrum with the spectrums of the samples.
5. Flames will combine the flame colors of the metals present. Stronger colors will mask less prominent colors, so the latter may not be visible.

Critical Thinking and Applications

1. Both the stars and the samples emit light. Scientists can compare the spectrums from the stars to the known spectrums of elements to determine what stars are made of.
2. Each person has a unique set of fingerprints. Similarly, each element has a unique set of spectral lines.
3. The responding variable is flame color, and the manipulated variable is the metal present.

More to Explore

Provide a variety of light sources (incandescent fluorescent, halogen bulbs), and suggest other feasible sources (sodium or mercury street lights, headlights). Spectrums should vary according to the type of light bulb.

Performance Assessment

1. The small object in the model must represent the object from the second column of the table.
2. The large object in the model must represent the object from the first column of the table.
3. Answers may vary. Possible answer: There are large differences in size between the categories of objects discussed.
4. Answers may vary but should include that the third object would have to be 100 times smaller or larger.
5. The ratio of the largest to smallest object would be about 10,000,000 to 1. If an object 1 mm in diameter were chosen as the smallest, the largest would be about 10 kilometers in diameter.
6. Students' diagrams should be similar to "The Lives of Stars" diagram in the textbook. A star's mass determines its life history.

Stars, Galaxies, and the Universe Chapter Test

1. b
2. b
3. d
4. a
5. a
6. b
7. c
8. b
9. b
10. a
11. eclipsing binary

12. radio telescope
13. refracting
14. reflecting
15. nebula
16. true
17. galaxy
18. true
19. apparent brightness
20. red
21. parallax
22. view 2
23. It is closer to Earth than star B.
24. A spectrograph breaks the light from an object into colors and makes an image of the resulting spectrum. Spectrums from different stars vary, depending on the temperature of the stars. Astronomers examine the spectrums of stars to determine what elements are in the stars and how much of each element there is.
25. A star's absolute brightness is how bright it would appear if it were at a standard distance from Earth. A star's apparent brightness is how bright it actually appears from Earth. Stars with much greater absolute brightness than the sun have apparent brightness much smaller than the sun because they are much farther away from Earth than the sun.
26. Hertzsprung-Russell diagram, or H-R diagram
27. Region B. Main sequence.
28. Region D contains the brightest stars. These stars would be supergiants.
29. About 5 billion years ago, a cloud of gas called the solar nebula started collapsing. Gradually, it formed a spinning disk. When gravity pulled enough gas into the center, it became hot and dense enough for nuclear fusion to begin. The sun was born. Elsewhere in the disk, small, asteroid-like bodies called planetesimals formed. The spheres closest to the sun lost most of their gases and became the inner planets. The spheres farthest from the sun became the gas giants. Outside the gas giants, a huge cloud formed. This cloud is probably the main source of comets. Pluto also formed in this region.
30. Spiral galaxies have long arms that spiral out from the center. Earth is in a spiral galaxy called the Milky Way. The spiral arms have many bright, young stars and large amounts of gas and dust. Elliptical galaxies look like round or flattened balls. They lack gas and dust, so new stars are no longer forming in them. Irregular galaxies have irregular shapes and many bright, young stars and lots of gas and dust to form new stars.