Astronomy

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Day 1: Astronomy The Original Science

- Identify the units of a calendar
- Describe 2 early ideas about the structure of the universe
- Describe the contributions of Brahe, Kepler, Galileo, Newton & Hubble to modern astronomy
- Astronomy the Original Science Worksheet

Day 2: Telescopes

- Compare refracting telescopes with reflecting telescopes
- Explain how the atmosphere limits astronomical observations And explain how astronomers over come these limitations.
- Telescopes worksheet
- Astronomy Word Search

Day 3: Constellations

- Define Constellations and Galaxies
- Discuss the origins of Constellations
- Organize the class into four groups for sky study And a Constellation Tour Project
- Spectacular Night Sky Work sheet

Day 4: Mapping the Sky

- Explain how constellations are used to organize the night sky
- Describe how the altitude of a star is measured.
- Explain how the celestial sphere is used to describe the location of objects in the sky.
- All students create an astrolabe
- Mapping the sky worksheet

Day 5: Mapping the Sky

- Compare results of Home sky Astrolabe lab
- Compare size and scale in the universe.
- Explain how red shift indicates that the universe is expanding.

Day 6: Review

- Complete Review - Reinforcement worksheet & key topics

Day 7: Test

Standards For Earth And Space Science
Grade 8

Strand III Earth and Space Science

Sub-Strand C. The Universe

Standard The student will compare objects in the solar system and explain their interactions with the Earth.

Benchmarks

1. The student will recognize that the sun is the principal energy source for the solar system and that this energy is transferred in the form of radiation.
2. The student will explain how the combination of the Earth's tilted axis and revolution around the sun causes the progression of the seasons and weather patterns.
3. The student will compare and contrast the planets, taking into Account their compositions, mass and distance from the sun and Recognize the conditions that allowed life to flourish on Earth.
4. The student will use the predictability of the motions of the Earth and sun to explain the length of day, length of year, phases of the moon, eclipses, tides and shadows.

Strand III Earth and Space Science

Sub-Strand C. The Universe

Standard The student will describe the composition and structure of the Universe

Benchmarks

1. The student will recognize that the universe consists of many of billions of galaxies, each containing many billions of stars and that there are vast distances that separate these galaxies and stars from one another.

2 The student will recognize that the sun is a medium-sized star and is the closest star to Earth. It is the central and largest body in the solar system and is one of billions of stars in the Milky Way Galaxy.

21 BRIGHTEST STARS IN THE SKY

STAR	CONSTELLATION	MAGNITUDE
1. Siruis	Canis Major	-1.46
2. Canopus	Carina	-0.72
3. Rigel Kentauras	Centaurus	-0.27 (dbl)
4. Arcturus	Bootes	- 0.04
5. Vega	Lyra the Harp	+ 0.03
6. Capella	Auriga	+0.08
7. Rigel	Orion	+0.12 (dbl)
8. Procyon	Canis Major	+ 0.38
9. Achernar	Eridanus	+ 0.46
10. Betelgeuse	Orion	+ 0.50
11. Hadar	Centaurus	+ 0.61
12. Altair	Auquila the Eagle	+ 0.77
13. Aldebaran	Taurus the Bull	+ 0.85 (var)
14. Acrux	Crux	+ 0.87
15. Antares	Scorpius	+ 0.96
16. Spica	Virgo	+0.98
17. Pollux	Gemini Twins	+ 1.14
18. Fomalhant	Piscis	+ 1.16
19. Deneb	Cygnus the Swan	+ 1.25
20. Mimosa	Crux	+ 1.25
21. Regulus	Leo the Lion	+ 1.35

(dbl) = Double star; combined magnitude of components is given

(var) = Variable star; Brightest magnitude is given

Ptolemy was a Greek astronomer who lived between 85-165 A.D. He put together his own ideas with those of Aristotle and Hipparchus and formed the geocentric theory. This theory states that the Earth was at the center of the universe and all other heavenly bodies circled it, a model which held for 1400 years until the time of Copernicus.
Ptolemy is also famous for his work in geography. He was the first person to use longitude and latitude lines to identify places on the face of the Earth.

Nicholas Copernicus was a Polish astronomer who lived between 1473-1543. Before his time, people believed in the Ptolemaic model of the solar system, which maintained that the Earth was the center of the universe.
Copernicus changed this belief when he introduced the heliocentric model, centered around the sun. He claimed that all the planets, including Earth, moved in orbits around the sun, and showed how this new system could accurately calculate the positions of the planets.

Tycho Brahe was a Danish astronomer who lived between 1546-1601. For over twenty years, he made very accurate observations of the night sky, all without the aid of a telescope, which had not yet been invented. Tycho also built the world's first observatory and kept a star catalogue with over 1000 stars.
Tycho's records were used by Johan Kepler to describe the orbits of planets around the sun and disprove the Ptolemaic theory.

Johan Kepler was a German astronomer who lived between 1571-1630. He introduced three important laws of planetary motion and helped the Copernican model of the solar system gain general acceptance.
Kepler inherited Tycho Brahe's observational data on Mars following Brahe's death and showed, mathematically, that Mars followed an elliptical orbit. This new revelation contradicted the age old belief that heavenly bodies all moved in perfect circles.
During his life, Kepler also cast horoscopes and wrote science fiction novels.

Galileo Galilei was an Italian astronomer and physicist who lived between 1564-1642. He challenged Aristotle's proposition that heavenly bodies were divine and therefore perfect and blemish-free.
Galileo was the first person to use a telescope to look at the heavens. He discovered sunspots, and craters and peaks in the moon. Galileo's work offended the Roman Catholic Church and he was sentenced to house arrest for the later years of his life. Today, he is remembered as a martyr for scientific truth.

Isaac Newton was an English scientist and mathematician who lived between 1642-1727. He had one of the most brilliant minds the world has ever known. Legend has it that seeing an apple fall gave Newton the idea that gravity, the force which keeps us bound to the Earth, also controls the motion of planets and stars.
Newton's contributions to science include the universal law of gravitation, the development of a whole new field in mathematics called calculus, and his famous three laws of motion

Albert Einstein was a German physicist who lived between 1879-1955. Probably the most well-known scientist of the twentieth century, Einstein came up with many original theories and invented modern physics.
He is most famous for his theory of relativity, which makes bold statements about the nature of light and also shows the relationship between mass and energy. Einstein's accurate predictions on the link between gravity with space and time also made him a celebrity.

Edwin Hubble was an American astronomer who lived between 1889-1953. His observations of galaxies helped him develop the idea of an expanding universe, which forms the basis of modern cosmology, the study of the origin of the universe. He also discovered a relationship between a galaxy's speed and its distance.
Hubble's studies were interrupted by service in both World Wars. The Hubble space telescope, currently on an observation project in space, bears his name.

History of the Telescope

Phoenicians cooking on sand discovered glass around 3500 BCE, but it took about 5,000 years more for glass to be shaped into a lens for the first telescope. A spectacle maker probably assembled the first telescope. Hans Lippershey (c1570-c1619) of Holland is often credited with the invention, but he almost certainly was not the first to make one. Lippershey was, however, the first to make the new device widely known.
The telescope was introduced to astronomy in 1609 by the great Italian scientist Galileo Galilei, who became the first man to see the craters of the moon, and who went on to discover sunspots, the four large moons of Jupiter, and the rings of Saturn. Galileo's telescope was similar to a pair of opera glasses in that it used an arrangement of glass lenses to magnify objects. This arrangement provided limited magnification--up to 30 times for Galileo--and a narrow field of view; Galileo could see no more than a quarter of the moon's face without repositioning his telescope.
In 1704, Sir Isaac Newton announced a new concept in telescope design whereby instead of glass lenses, a curved mirror was used to gather in light and reflect it back to a point of focus. This reflecting mirror acts like a light-collecting bucket: the bigger the bucket, the more light it can collect. The reflector telescope that Newton designed opened the door to magnifying objects millions of times--far beyond what could ever be obtained with a lens.
Newton's fundamental principle of using a single curved mirror to gather in light remained the same. The major change that took place was the growth in the size of the reflecting mirror, from the 6-inch mirror used by Newton to the 6-meter (236 inches in diameter) mirror of the Special Astrophysical Observatory in Russia, which opened in 1974.
The idea of a segmented mirror dated back to the 19th century, but experiments with it had been few and small, and many astronomers doubted its viability. It remained for the Keck Telescope to push the technology forward and bring into reality this innovative design.
A binocular is a optical instrument for providing a magnified view of distant objects, consisting of two similar telescopes, one for each eye, mounted on a single frame. The first binocular telescope was invented by J. P. Lemiere in 1825.

Early telescopes, like Galileo's, were designed on the principles of refraction, or redirecting light by bending its rays as it passes from one medium, like air, into and out of another medium, like glass. A convex objective lens, located at one end of the telescope's tubular body, gathered as much light as possible from a distant object. The larger the lens, the more light it could gather. As light rays passed through the objective lens, its curvature directed the rays to converge and form an image of the viewed object near the other end of the tube, at a place called the focal plane. A concave eyepiece then magnified the tiny image for the viewer to see.

The lenses in Galileo's telescope had a greenish hue from iron contained in the glass and were filled with tiny bubbles that distorted the image. In addition, as explained in more detail below, a colored halo surrounded the images seen in the small field of view. Yet another shortcoming of Galileo's telescope was that magnification could only be improved by increasing the focal length, which meant focusing the light farther behind the objective lens. Tubes were made longer and lenses larger, but there were practical limits to this design: a glass lens large enough to capture the sparse rays from more distant stellar objects would sag under its own weight.

Isaac Newton introduced a new concept in telescope design in which mirrors replaced glass lenses. In a reflecting telescope, a curved concave mirror at the base of the tube gathered light and reflected it to a point of focus situated about halfway back along the tube. There, a second mirror -- flat and angled -- reflected light to an eyepiece located on the side of the tube.

Newton's design held some distinct advantages over Galileo's. For example, lenses naturally cause different wavelengths of light to separate as they pass through them. Light of different colors focuses at different points, causing distortions in the color of the objects under observation, especially around their edges. Mirrors, by contrast, do not separate the colors in this way.

Telescope

Sir Isaac Newton once wrote, in what must be one of the most oft-quoted lines in the history of science, "If I have seen further it is by standing upon the shoulders of giants." Well, any of us who has ever looked through a telescope could say the same, for the two principal types in use today were developed by giants: the refractor by Galileo and the reflector by Newton. Those two scientific geniuses, as Sir Isaac himself acknowledged, built upon the work of others, and how they came to design their inventions offers a compelling glance at the workings both of the telescope and of the scientific process itself.

Making the far near

The invention that set the stage for the telescope was the eyeglass, which appeared in the mid-13th century. The first spectacles, designed to correct farsightedness, bore glass magnifiers that were biconvex, meaning they curved outward on both sides. (Each resembled a lentil, or *lens* in Latin.) Mostly used to help older people read, these lenses focused on objects between 12 and 20 inches away from the eye.

Nearsightedness, a more common affliction, proved more difficult to correct. It required biconcave lenses—those curving inward on each surface—that had to bring objects into focus at the specific distance at which one's eyesight failed. The poorer one's vision, the greater the distance the lenses needed to provide focus.

In 1608, someone in Europe—it's not clear who—figured out that if you placed a lens for the farsighted about 12 to 14 inches away from a lens for the nearsighted, and then peered through the latter lens, distant objects would miraculously appear as if close by. (Oh, to have seen that pioneer's expression upon first realizing this!) Place those lenses in a tube and voilà, you have a spyglass.

Within months, Galileo had not only learned of the new device but was well on his way to improving its design. In his workshop in Padua, Italy, he discovered that plano-convex and plano-concave lenses worked best—that is, lenses with a plane on one side and curved surfaces on the other. Then, drawing on his skills as a professor of mathematics at the University of Padua, he determined the mathematical relationship that governed the instrument's ability to magnify. A spyglass with a plano-convex lens that focuses at 12 inches and a plano-concave lens that focuses at four inches, he found, magnifies images three times (12 divided by four). Galileo played with this formula until, by the late fall of 1609, he'd made a spyglass that could magnify what is seen by 20 times. No other spyglass maker could match that.

That fall, Galileo also did what apparently no one else had ever done with a spyglass before: train the instrument on the heavens. In short order he began making astronomical findings that would shake our understanding of our place in the universe to its foundations. Among them was the discovery of four moons orbiting Jupiter. To Galileo, the moons proved that not everything in space circled the Earth, and therefore our planet was not the absolute center of the universe, as the Church maintained the Bible had it.

Building a better refractor

The spyglass-turned-telescope had limitations, some of which Galileo was able to design around. To reduce distortions such as elongations and blurriness caused by the curvature of the "objective" lens—the convex lens at the far end of the telescope—Galileo ground a lens larger than he needed, for example. He then placed cardboard around the edges of the lens so that light entered that portion of the lens where curvature-related distortions were

least apparent.
Other problems Galileo would have to leave to others. One concerned magnification. In striving to make images he saw through his telescope ever larger, Galileo found that his field of view became ever smaller. He reached a point of diminishing returns beyond which enlarging the image made what was seen through the telescope too small to be of practical use. That point, he found, was achieved when he succeeded in magnifying the image 20 or 30 times.
Galileo's contemporary Johannes Kepler, a German mathematician, discovered a way to get beyond the magnification ceiling. Instead of a concave lens near the eye, Kepler used a convex lens. The result was that the image magnified by the convex objective lens was further magnified by the now-convex eyepiece lens. The only problem was that the resulting image was upside down. Some astronomers added a third convex lens to right the image, but this added unwanted distortions. Eventually, most astronomers simply accepted the inverted view. After all, did it really matter that they were seeing planets and stars upside down?
Kepler's advance created a new challenge, however. Because his telescope offered a much greater field of view, astronomers had plenty of room to improve magnification. One way to do that, they knew, was to make the focal length of the eyepiece shorter. This, however, increased the curvature of the lens, which exacerbated the distracting fringes of color that surrounded images. The other way was to reduce the curvature of the objective lens. This results in fewer color problems, because the less a lens is curved the less it acts like a prism. But this made the focal length of the objective lens—and thus the instrument itself—longer. As Richard Panek writes in his book *Seeing and Believing: How the Telescope Opened Our Eyes and Minds to the Heavens,* things got a little out of hand:
Six to eight feet—that was the length of a good astronomical telescope in 1645. Five years later it was 10 to 15 feet. Ten years after that, 25 feet. Ten years after that, 40 to 50 feet. By 1673, [Polish astronomer] Johannes Hevelius had constructed a telescope 150 feet long on the shores of the Baltic Sea....One astronomer cheered the coming day when aerial telescopes would have a focus of 1,000 feet and human spectators could marvel at the antics of the animals on the Moon.
Alas, extremely long telescopes proved to be impracticable. Most useful were those no longer than 30 or 40 feet—as Panek says, "long but not *that* long...."

Goodbye to color

Designers of shorter telescopes still faced the problem of chromatic aberrations, though—that is, until Isaac Newton solved it. In 1672, Newton published a seminal paper on light and color, in which he showed that white light is a mixture of all colors of the spectrum. When white light passes through a curved lens it breaks down into its various component colors, each of which comes into focus at a different point on the optical axis—hence the color fringes seen in refractors.
Other scientists had speculated that using mirrors rather than lenses might correct this problem, but Newton was the first to put such thoughts into practice. He cast a two-inch metal mirror and ground it so that it had a spherical curvature. He placed the mirror at one end of a tube. Light coming in the other end reflected off the mirror back toward the opening. The reflected light struck a secondary mirror Newton had affixed inside the tube at a 45-degree angle. That secondary mirror, in turn, bounced the light (and thus the image

seen) into a convex eyepiece lens built into the side of the tube.

This was the first working reflecting telescope. Other designers proved unable to grind mirrors with a regular curvature, so the reflector remained largely a curiosity until the mid-18th century, when it finally began to come into its own.

Standing on shoulders

Both types of telescopes—Galileo's refractor and Newton's reflector—underwent improvements in the coming centuries. Designers of refracting telescopes figured out, for one, that by using two different kinds of glass together in the objective lens, they could cause the red and blue ends of the spectrum to converge towards a single focal point, thereby solving the color-fringe problem. Despite myriad embellishments, however, most optical telescopes in use in the 21st century derive from the two types developed in the 17th century by Galileo and Newton, on whose shoulders all astronomers, both amateur and professional, stand today

Making an Astrolabe

In this activity you will make an astronomical device called an astrolabe.

Ancient astronomers use astrolabes to measure the location of stars in the sky and to help them navigate. For around two thousand years now, people have been using astrolabes for navigation. The Greeks are credited with inventing the instrument. Moslems were using astrolabes by the eighth century, and in 1381 the English author Geoffrey Chaucer wrote a Treatise on the Astrolabe. But the astrolabe's heyday was in the navigational boom of the 1400 and 1500s. Now the Global Positioning System has eliminated the need for navigation by the stars, except perhaps in emergency situations, but it is still an interesting skill to know.

You will use the astrolabe to measure the angle or altitude of an object.

Procedure:
1. Tie one end of a piece of string that is 15cm long to the center of the straight edge of a protractor. Attach a paper clip or washer to the other end of the string.

2. Tape a straw lengthwise along the straight edge of the protractor.

Your astrolabe is complete!

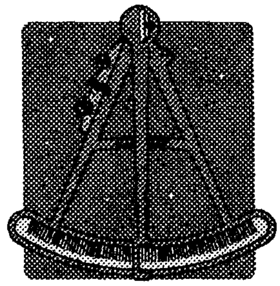
3. Look through the straw at a distant object. The curve of the astrolabe should point toward the ground.
4. Hold the astrolabe still and carefully pinch the string to the protractor. Count the number of degrees between the string and 90 degrees. Or subtract the number you have from 90 and that is the altitude.

If outside at night you can:
Locate Polaris, then use your astrolabe to find its altitude. Sight the star through the straw and note what degree the string lines up at on the protractor. (Read the inner set of numbers, from 0-90 degrees.) This number is the zenith angle. To find the altitude angle, subtract the zenith angle from 90 degrees. This number will be the same as, or very close to, the latitude at your sighting location.

Analysis:

1. What is the altitude of the object? How would the altitude change if you moved closer to the object?

2. Explain how you would use an astrolabe to find the altitude of a star. What are the advantage and disadvantages of this method of measurement?



Astrolabe Activity

LP ______________________ **Date** ____________________

Objectives:

- To learn how to use an astrolabe
- To define the term altitude
- To understand the relationship between angle and altitude
- To understand the relationship between the altitude of Polaris and latitude

Materials:

1. Class set of astrolabes made by teacher
2. Or, each student can make and keep their astrolabe prior to this activity.

Procedure:

1. Using your Astrolabe, find the angle in degrees (altitude) of the following objects in our classroom. Then, chose 4 objects of your choice.
2. When making your measurements, stand as far away from the object as you can.
3. Record your measurements in the table provided.

Object being measured	Angle in degrees (Altitude)
Middle of Clock	
Pulley of the planetarium	
Fire alarm	
Kermit's left eye	
Top of front wall	
Top of the T.V.	
Your choice ____________________	
Your choice ____________________	
Your choice ____________________	
Your choice ____________________	

Analysis and Results:

1. Define the word **altitude**: ____

____

2. When measuring **inside** the classroom, how does distance affect the altitude?

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____
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3. When measuring celestial bodies from Earth, does where you stand affect the altitude? Compare standing in your backyard, standing in another state, and another country.

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4. The latitude of Englewood, NJ is 40°N and the altitude of Polaris is 40 degrees. What is the **altitude** of **Polaris** at these cities?

City	Latitude	Altitude of Polaris
London, England	**51°N**	
Panama City, Panama	**9°N**	
Hammerfest, Norway	**70°N**	
Cairo, Egypt	**30°N**	
San Juan, Puerto Rico	**18°N**	
North Pole	**90°N**	
Sydney, Australia	**33°S**	

Conclusion: 2-3 complete sentences on what you learned by doing this activity.

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Name ______________________________ Class ______________ Date ____________

Skills Worksheet

Directed Reading A

Section: Astronomy: The Original Science

1. In what way did people in ancient cultures mark the passage of time?

____

2. What science did the study of the night sky eventually become?

____

OUR MODERN CALENDAR

Match the correct definition with the correct term. Write the letter in the space provided.

______ 3. roughly the amount of time required for the moon to orbit once around the Earth

______ 4. the time required for the Earth to orbit once around the sun

______ 5. the time required for the Earth to rotate once on its axis

a. day

b. month

c. year

WHO'S WHO OF EARLY ASTRONOMY

______ 6. Most early astronomers thought that the universe consisted of
- **a.** the sun and the Earth.
- **b.** the sun and the planets.
- **c.** the sun, the moon, and the planets.
- **d.** the sun, the moon, and the Earth.

______ 7. What was Ptolemy's theory of the universe?
- **a.** The Earth was at the center of the universe, and the sun, moon, and other planets revolved around it.
- **b.** The sun was at the center of the universe, and the Earth and the other planets revolved around it.
- **c.** The sun and the moon revolved around the Earth, but the other planets revolved around the sun.
- **d.** The planets revolved around the sun in elliptical orbits.

______ **8.** How long did Ptolemy's Earth-centered theory remain the popular theory for the structure of the universe?
a. about 100 years
b. about 500 years
c. over 1,500 years
d. over 5,000 years

______ **9.** Why was Ptolemy's theory of the universe helpful even though it was incorrect?
a. It helped revolutionize astronomy.
b. It predicted the motions of the planets better than any other theory at the time.
c. It promoted new research in the study of the universe.
d. It explained the sun's role in the universe.

______ **10.** What was Copernicus's theory of the universe?
a. The Earth was at the center of the universe, and the sun, moon, and other planets revolved around it.
b. The sun was at the center of the universe, and the Earth and the other planets revolved around it.
c. The sun and moon revolved around Earth, but the other planets revolved around the sun.
d. The planets revolved around the sun in elliptical orbits.

______ **11.** Which astronomer's theory led to major changes in science and society?
a. Hubble
b. Brahe
c. Ptolemy
d. Copernicus

______ **12.** What was Brahe's theory of the universe?
a. The Earth was at the center of the universe, and the sun, moon, and other planets revolved around it.
b. The sun was at the center of the universe, and the Earth and the other planets revolved around it.
c. The sun and moon revolved around Earth, but the other planets revolved around the sun.
d. The planets revolved around the sun in elliptical orbits.

______ **13.** Why was Brahe's work helpful even though his theory of the universe was incorrect?
a. He accurately described the planets' orbits.
b. He made detailed measurements of the sun.
c. He explained the sun's role in the universe.
d. He made very precise observations of the planets and stars.

______14. What did Kepler believe about the universe?

a. The Earth was at the center of the universe, and the sun, moon, and other planets revolved around it.

b. The sun was at the center of the universe, and the Earth and the other planets revolved around it.

c. The sun and moon revolved around Earth, but the other planets revolved around the sun.

d. The planets revolved around the sun in elliptical orbits.

______15. What laws did Kepler state that are still in use today?

a. laws of planetary names

b. laws of planetary motion

c. laws of solar motion

d. laws of gravity

______16. Who was one of the first scientists to use a telescope?

a. Galileo

b. Kepler

c. Newton

d. Hubble

17. What four discoveries did Galileo make that showed planets are physical bodies like the Earth and not "wandering stars"?

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18. What did Newton prove about gravity?

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19. Newton's laws of motion and gravity helped to explain many other scientists' observations. For example, what law announced by Kepler was supported by Newton's laws?

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MODERN ASTRONOMY

20. What were two milestones in the development of modern astronomy?

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21. What did many astronomers believe about galaxies prior to the 1920s?

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22. What did Edwin Hubble prove in 1924?

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23. What belief of other astronomers did Edwin Hubble's discovery confirm?

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24. What tools do astronomers use to study space?

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25. How are computers used to study space?

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Name ______________________ Class ______________ Date ______________

Skills Worksheet

Directed Reading A

Section: Telescopes

1. An instrument that gathers electromagnetic radiation and concentrates it for better observation is a(n) ______________________.

2. The most common type of telescope is the ______________________ telescope.

OPTICAL TELESCOPES

______ 3. An optical telescope is an instrument that
   a. collects and focuses visible light for closer observation.
   b. collects and focuses invisible light for closer observation.
   c. collects visible light and breaks it apart.
   d. collects invisible light and breaks it apart.

______ 4. The simplest optical telescope contains
   a. an objective lens and a mirror.
   b. two objective lenses.
   c. an obtuse lens and a lens in the eyepiece of the telescope.
   d. an objective lens and a lens in the eyepiece of the telescope.

5. What is the function of the objective lens?

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6. What is the function of the lens in the eyepiece?

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____

Two types of optical telescopes are refracting telescopes and reflecting telescopes. In the space provided, write FR if the phrase describes a refracting telescope and FL if the phrase describes a reflecting telescope.

______ **7.** uses lenses to gather and focus light

______ **8.** uses mirrors to gather and focus light

______ **9.** used by most professional astronomers

______ **10.** cannot focus images perfectly

______ **11.** focuses all colors of light to the same focal point

______ **12.** distorts images if lens is too large

______ **13.** can use large mirrors to gather light

______ **14.** flaws in the glass don't affect the collected light

15. What are two disadvantages of refracting telescopes?

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16. What are three advantages of reflecting telescopes?

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17. What do very large reflecting telescopes use to gather more light and focus it in one spot?

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18. How does the Earth's atmosphere affect the light gathered by telescopes on Earth?

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19. Why is a mountaintop a good place on Earth to put a telescope?

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20. What is the best place to put a telescope? Explain why.

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THE ELECTROMAGNETIC SPECTRUM

______**21.** What did James Clerk Maxwell prove about visible light?

a. It is the only form of radiation.
b. It is made up of magnetic elements.
c. It is part of the electromagnetic spectrum.
d. It cannot be detected by the human eye.

______**22.** Each color of light on the electromagnetic spectrum has a

a. different form of magnetic energy.
b. different wavelength of electromagnetic radiation.
c. different type of gamma rays.
d. different type of radio waves.

______**23.** Humans can see radiation from

a. ultraviolet light.
b. infrared light to ultraviolet light.
c. infrared light.
d. red light to blue light.

24. Place the following types of radiation in order from shortest wavelength to longest wavelength: microwaves, gamma rays, radio waves, X rays.

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Each of the following wavelengths is either blocked or unblocked by the Earth's atmosphere. In the space provided, write B if the wavelength is blocked and U if the wavelength is unblocked.

______**25.** infrared light

______**26.** gamma rays

______**27.** X rays

______**28.** visible light

______**29.** microwaves

NONOPTICAL TELESCOPES

30. Why do astronomers study the entire electromagnetic spectrum?

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31. Radio telescopes are much larger than ____________________ telescopes because radio wavelengths are much longer than optical wavelengths.

32. The ____________________ of a radio telescope can be more flawed than the lenses and mirrors of an optical telescope.

33. Why can chicken wire be used as the surface of a radio telescope?

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34. Why have scientists put ultraviolet, infrared, gamma-ray, and X ray telescopes in space?

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____

WordSearch 09/27/06, Earth Science

Name ____________________ Date __________

Instructions: Complete the puzzle. Use the clues to help you find and circle the terms hidden in the puzzle.

Z	M	U	K	G	R	T	X	P	E	D	L	C	O	N	S	T	E	L	L	A	T	I	O	N	A	G
A	H	R	M	B	E	Z	B	H	S	X	Q	G	A	I	P	J	P	J	V	C	M	Z	U	X	A	D
U	P	N	I	U	H	I	Z	K	O	D	P	T	U	B	G	D	M	X	N	U	G	Y	E	I	W	A
M	T	H	B	A	K	Q	F	E	K	R	L	V	X	W	Y	B	O	O	L	Q	R	M	E	W	D	Y
R	Q	C	Y	Q	W	F	G	O	Q	R	I	F	I	O	P	K	P	J	I	G	D	L	P	G	Y	J
E	K	L	K	B	V	E	T	F	I	U	Y	Z	K	A	J	B	B	S	C	S	U	W	F	W	V	B
P	H	F	Z	H	B	X	P	C	Z	D	N	U	O	P	E	S	N	U	Y	N	G	T	T	X	P	E
O	N	B	H	J	A	N	V	Y	Q	V	Y	B	U	N	J	U	A	Z	G	O	C	C	T	C	F	B
C	R	A	E	Y	C	E	X	W	U	U	N	B	V	F	F	M	J	B	L	T	H	W	K	B	Y	Y
S	E	K	D	W	O	D	O	Q	L	C	Y	O	U	C	L	A	Y	E	Q	J	Z	A	I	T	Q	X
E	A	C	S	C	S	F	D	U	G	D	I	Z	G	P	Q	H	A	S	I	V	S	V	E	K	T	K
L	Y	S	D	F	V	E	J	N	R	G	F	B	W	S	K	I	M	M	S	A	Z	D	N	Y	M	B
E	I	K	Q	G	S	N	C	K	S	R	P	P	H	H	C	O	B	H	Z	J	Q	J	I	T	V	D
T	K	G	Z	M	Z	E	R	E	F	R	A	C	T	I	N	G	T	E	L	E	S	C	O	P	E	K
G	Z	V	H	N	G	X	D	Q	A	W	P	M	Q	T	S	O	A	L	T	I	T	U	D	E	L	F
N	R	H	O	T	O	P	A	Q	E	C	Z	A	H	T	J	T	Y	S	H	D	I	K	B	C	J	Y
I	Z	H	N	F	Y	N	Q	P	S	O	H	X	U	J	R	I	K	N	O	H	T	I	N	E	Z	T
T	A	U	N	W	Z	E	O	W	S	R	Q	E	R	B	Y	C	K	E	G	M	O	M	D	S	A	L
C	Q	O	N	T	B	C	A	S	Y	O	Y	Y	Z	K	X	B	W	Z	D	E	B	H	D	S	T	I
E	X	K	A	O	S	N	U	R	V	H	K	D	F	A	Y	M	O	N	O	R	T	S	A	F	S	H
L	S	L	F	E	B	Y	X	B	M	O	B	A	W	P	G	K	D	Z	Y	A	R	H	V	G	O	Q
F	K	G	L	U	O	D	T	O	J	T	H	F	P	Z	J	L	Q	D	E	W	L	U	L	F	Q	C
E	T	E	M	E	A	D	M	N	P	O	G	N	F	R	U	M	F	Q	E	R	G	I	O	J	L	W
R	T	E	U	P	C	Q	Y	N	P	I	Z	B	O	X	A	N	M	G	H	Y	W	C	X	G	B	Y
Z	Q	V	E	L	E	C	T	R	O	M	A	G	N	E	T	I	C	S	P	E	C	T	R	U	M	H
F	B	U	V	Q	A	Z	C	O	P	F	U	Z	M	X	J	I	J	P	S	V	J	N	Q	X	F	E
G	X	O	K	K	Q	C	W	T	Z	E	M	B	N	A	M	J	U	P	X	M	U	H	N	J	C	S

Clues:

1. telescope
2. year
3. horizon
4. day
5. month
6. refracting telescope
7. astronomy
8. altitude
9. zenith
10. light-year
11. constellation
12. reflecting telescope
13. electromagnetic spectrum

Scramble 09/27/06, Earth Science

Name ______________________ Date __________

Instructions: Complete the puzzle. Use the clues to help you unscramble the terms

1. D Y A
□□□

2. I E R A L - H Y T G
□□□□□□□□□□

3. R Y E A
□□□□

4. N C I T L T E M C A R E G E O T R P S U M C E
□□□□□□□□□□□□□□□ □□□□□□□□

5. O E I L A L O C T S N T N
□□□□□□□□□□□□□

6. M Y T O O R A S N
□□□□□□□□□

7. H Z N T E I
□□□□□□

8. N H R I Z O O
□□□□□□□

9. A E D L I T T U
□□□□□□□□

10. S L P O C E T E E
□□□□□□□□□

11. C F E A R G T I N R E O E P T C E S L
□□□□□□□□□□ □□□□□□□□□

12. T N C E F E R L I G E L S C P E T E O
□□□□□□□□□□ □□□□□□□□□

13. M O T N H
□□□□□

Clues:

1. the time required for Earth to rotate once on its axis
2. the distance that light travels in one year; about 9.46 trillion kilometers
3. the time required for the Earth to orbit once around the sun
4. all of the frequencies or wavelengths of electromagnetic radiation
5. a region of the sky that contains a recognizable star pattern and that is used to describe the location of objects in space

Info For Chapter 18 test

Altitude	Zenith
Horizon	vernal Equinox
Light-Year	Celestial Sphere
Kepler	Newton
Hubble	Galileo
Telescope	Electromagnetic Spectrum
Reflecting Telescope	Refracting Telescope
Tycho Brahe	Copernicus
Ptolemy	day
Year	month
Celestial sphere	declination
Ecliptic	constellation
Right ancension	Doppler Effect
Red Shift	Blue Shift
Circumpolar	Know the Electromag. Spectrum

How does earths atmosphere affect starlight

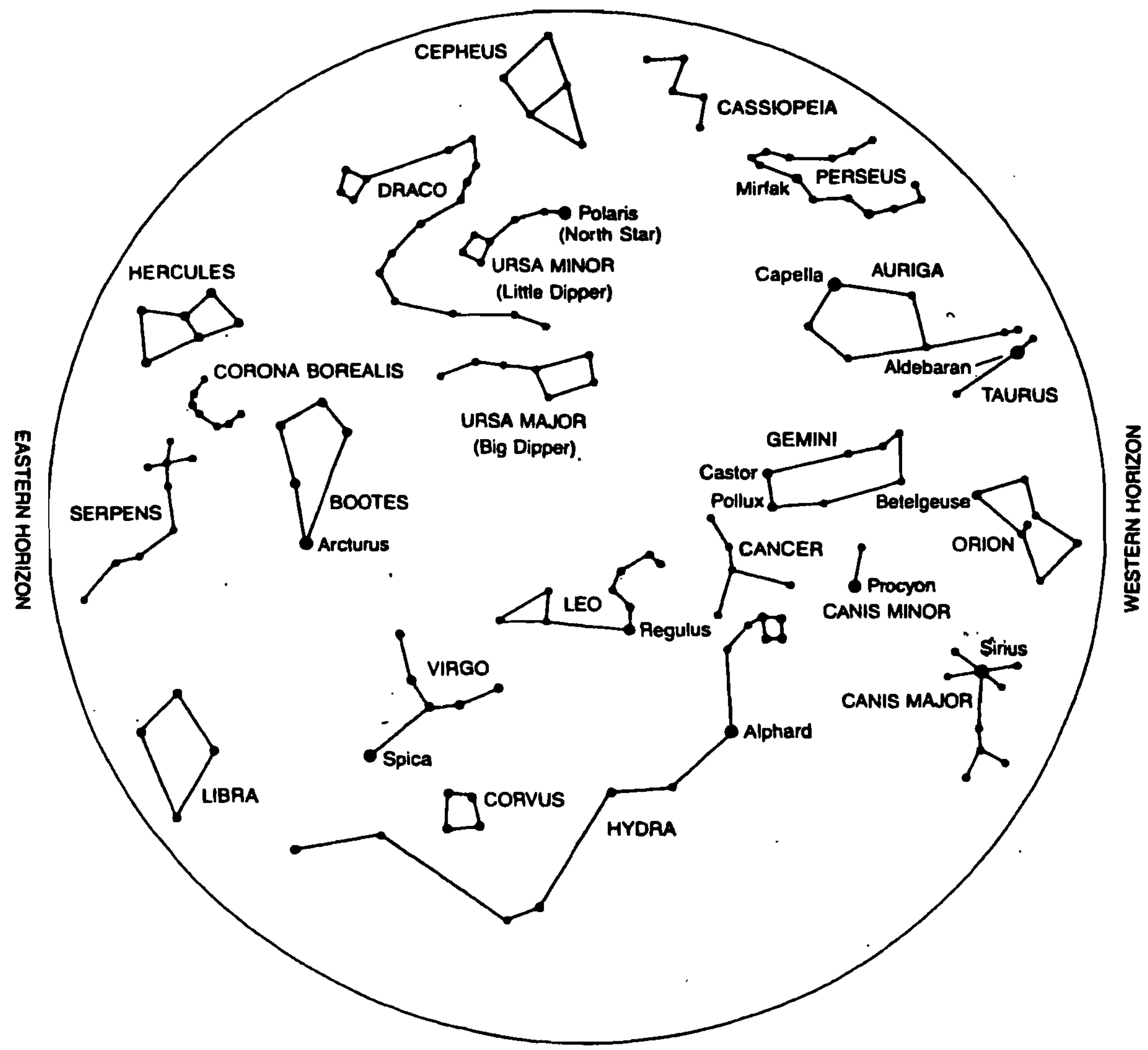
6. the study of the universe
7. the point in the sky directly above an observer on Earth
8. the line where the sky and the Earth appear to meet
9. the angle between an object in the sky and the horizon
10. an instrument that collects electromagnetic radiation from the sky and concentrates it for better observation
11. a telescope that uses a set of lenses to gather and focus light from distant objects
12. a telescope that uses a curved mirror to gather and focus light from distant objects
13. a division of the year that is based on the orbit of the moon around the Earth

ACTIVITY ■ Stars and Galaxies

Spectacular Night Sky

Interest in the night sky led primitive people to study the patterns of stars they saw and to give these patterns names. The patterns, or constellations, were named in honor of various mythological characters. In all, some 88 constellations have been identified. Some are easy to locate in the night sky while others are not. Can you think of some explanations for this?

The diagram below is a star chart of the spring sky in a particular location. The outer edge of the circle represents the horizon as the observer faces north, south, east, or west. To use the star chart, you would place the paper horizontally above your head and align the correct edge of the circle with the direction in which you are facing.



1. In which direction should you face to see the constellation Ursa Minor? ______________

____

2. What well-known star is the tip of the handle of Ursa Minor? ______________

____

3. Which constellation is directly overhead in spring? ______________

____

4. What is another name for the Big Dipper? ______________

____

5. How can you use the Big Dipper to find the Little Dipper? ______________

____

____

6. In which constellation is the star Sirius located? ______________

____

7. Why is Sirius easy to identify? ______________

____

8. In which direction would an observer have to look to see the constellation Taurus?

____

____

9. Why do the stars in the night sky appear to twinkle? ______________

____

____

____

10. How many stars can be seen in the night sky by any one observer at any one time?

____

____

11. How many constellations can you identify in the night sky? ______________

____

Name ______________________________ Class ______________ Date ______

CHAPTE 2

ACTIVITY ■ Stars and Galaxies

Naming Constellations

Ask your friends what sign they were born under and they can probably tell you immediately. These zodiac signs are actually the names ancient peoples gave to various constellations, or star groups. You will find a list of constellations below. However, in each case, either the constellation's name or its English equivalent has been left out. Fill in the constellation's name or its English equivalent in the appropriate space.

Constellation	English Name
1. Aquarius	______________
2. ______________	Ram
3. Cancer	______________
4. Capricornus	______________
5. ______________	Princess
6. Aquila	______________
7. ______________	Swan
8. ______________	Dragon
9. Gemini	______________
10. Hercules	______________
11. ______________	Lion
12. Libra	______________
13. ______________	Wolf
14. Hydra	______________
15. Orion	______________
16. ______________	Winged horse
17. ______________	Scorpion
18. Taurus	______________

19. Cassiopeia	____________________
20. ____________________	Fish
21. Sagittarius	____________________
22. ____________________	Great bear
23. Ursa Minor	____________________

Name ______________________ Class ____________ Date ____________

Skills Worksheet

Directed Reading A

Section: Mapping the Stars

1. How did ancient cultures group the stars in the sky?

____

____

____

2. What are two things that people have a better understanding of as a result of advances in astronomy?

____

____

____

PATTERNS IN THE SKY

______ 3. What are constellations?
- **a.** regions of the sky that contain recognizable star patterns
- **b.** stars
- **c.** star patterns
- **d.** galaxies

______ 4. How did people in ancient cultures use the locations and movements of constellations?
- **a.** to create land boundaries
- **b.** to make roads
- **c.** to measure the universe
- **d.** to navigate and keep track of time

______ 5. The ancient Greek constellation Orion was the same as
- **a.** the Japanese constellation of a hunter.
- **b.** the Japanese constellation of a drum.
- **c.** the Great Bear.
- **d.** the Ursa Major.

______ 6. Which of the following is true of constellations?
- **a.** All cultures interpret the sky in the same way.
- **b.** Every star or galaxy belongs to a constellation.
- **c.** All ancient civilizations had the same names for the same constellations.
- **d.** Astronomers disagree on the names and locations of the constellations.

______ **7.** How many constellations are there?
- **a.** 88
- **b.** 128
- **c.** over 1,000
- **d.** over 10,000

______ **8.** The apparent locations of constellations in the night sky change their locations
- **a.** every day.
- **b.** from season to season.
- **c.** every year.
- **d.** every other year.

______ **9.** Why do constellations seem to change locations with the seasons?
- **a.** because the Earth tilts on its axis
- **b.** because the Earth revolves around the sun
- **c.** because the stars rotate around the Earth
- **d.** because of an astronomical optical illusion

______ **10.** Which of the following is true of constellations?
- **a.** People in all parts of the world see the same constellations.
- **b.** People in Chile see the same constellations as people in the United States.
- **c.** People in the Northern Hemisphere see the same constellations as people in the Southern Hemisphere.
- **d.** People in the Northern Hemisphere see different constellations than people in the Southern Hemisphere.

FINDING STARS IN THE NIGHT SKY

11. An instrument that is used to determine a star or planet's location is a(n)

______________________.

12. What are three reference points used to describe a star or planet's position in relation to a person's position?

____

____

____

Match the correct definition with the correct term. Write the letter in the space provided.

______ **13.** an imaginary point directly above an observer's head

______ **14.** the line where the sky and the Earth appear to meet

______ **15.** the angle between an object in the sky and the horizon

______ **16.** an imaginary sphere that surrounds the Earth

______ **17.** an imaginary extension of the Earth's equator into space

a. zenith
b. celestial equator
c. horizon
d. altitude
e. celestial sphere

18. The location of the sun on the first day of spring is the

______________________.

19. Astronomers measure ______________________ in hours by how far east an object is from the vernal equinox.

20. Astronomers measure ______________________ in degrees by how far north or south an object is from the celestial equator.

21. Some stars located near Earth's poles can be seen year-round, at all times of night. What are these stars called?

____

____

____

THE SIZE AND SCALE OF THE UNIVERSE

______ **22.** A light-year is equal to the distance that light travels in
a. 1 month.
b. 1 year.
c. 9.46 years.
d. 9.46 trillion years.

______ **23.** One light-year is about 9.46 trillion
a. yards.
b. meters.
c. kilometers.
d. miles.

______**24.** How far away is the most distant object we can see?
a. about 1 billion light-years
b. 9.46 billion light-years
c. more than 10 billion light-years
d. about 100 billion light-years

THE DOPPLER EFFECT

______**25.** What is the name of the effect that describes how the pitch of a sound seems higher as it gets closer and lower as it gets farther away?
a. sound effect
b. wavelength effect
c. drowser effect
d. doppler effect

______**26.** When a star or galaxy moves quickly away from an observer, the light it emits
a. appears bluer than it usually would.
b. appears redder than it usually would.
c. appears darker than it usually would.
d. appears lighter than it usually would.

______**27.** When a star or galaxy moves quickly toward an observer, the light it emits
a. appears bluer than it usually would.
b. appears redder than it usually would.
c. appears darker than it usually would.
d. appears lighter than it usually would.

28. An effect in which a star or galaxy appears to move quickly away from an observer is called ______________________.

29. An effect in which a star or galaxy appears to move quickly toward an observer is called ______________________.

30. Edwin Hubble discovered that the light from all galaxies except the Milky Way's close neighbors is affected by ______________________.

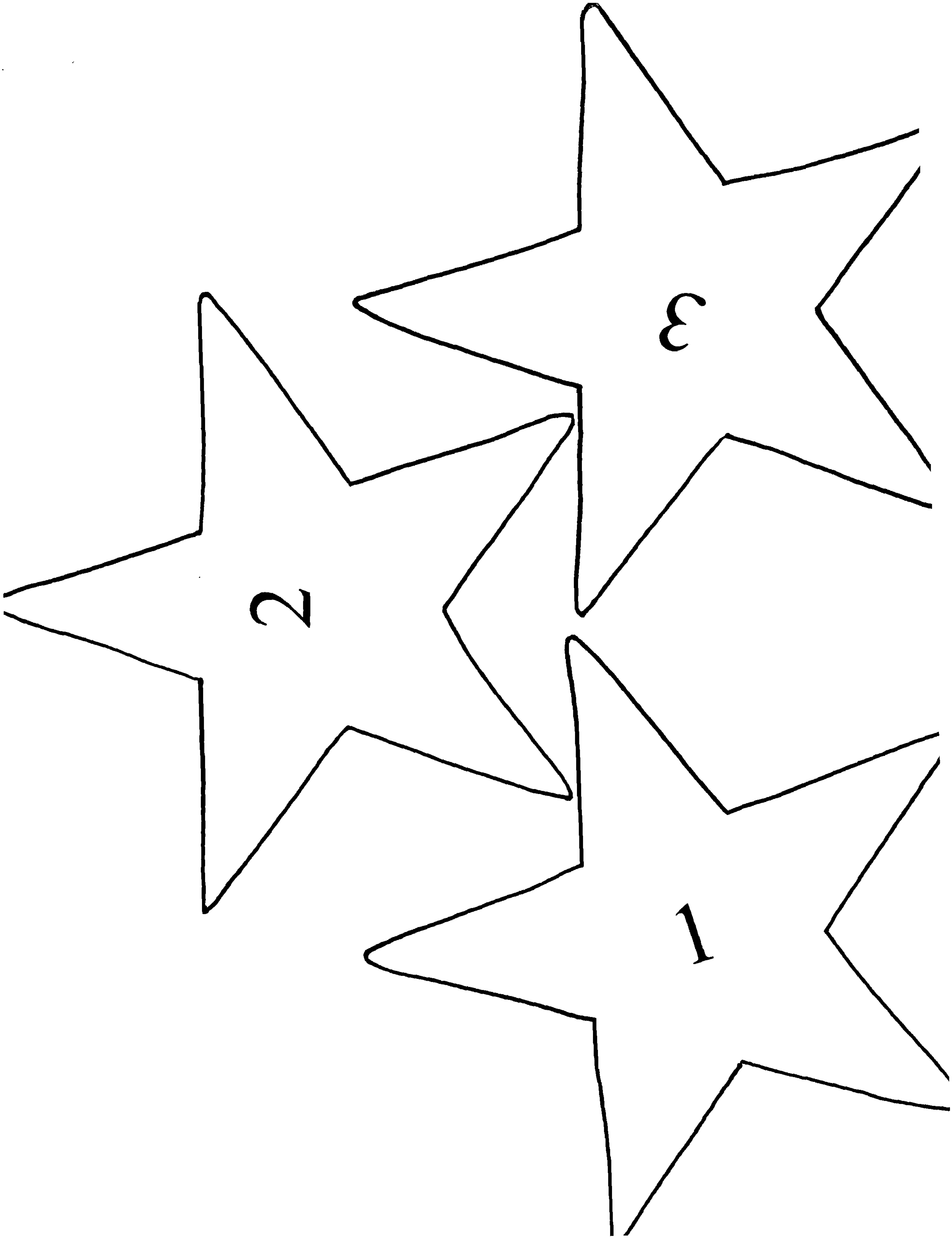
31. How did Edwin Hubble determine that the universe must be expanding?

____

____

____

____


3
2
1

Skills Worksheet

Reinforcement

Complete this worksheet after you finish reading the section "Astronomy: The Original Science."

Stella Star, a reporter for the *Back in Times*, interviewed scientists for an article she is writing on the history of astronomy. She interviewed Ptolemy, Kepler, Copernicus, Newton, Galileo, Brahe, and Hubble. When Stella looked over her notes, she discovered that she forgot to indicate which scientist said what. Help Stella organize her notes by identifying the scientist most likely to have said each statement. Write your answer in the space provided.

Ptolemy	Kepler	Copernicus	Newton
Galileo	Brahe	Hubble	

______________ **1.** "I've finally worked out an explanation as to why planets orbit the sun and moons orbit planets. It is gravity that keeps an object in orbit!"

______________ **2.** "The Earth is the center of the universe, and all of the planets and stars orbit our planet. My theory predicts the motion of the planets better than any other theory of my day."

______________ **3.** "It appears the Milky Way has neighbors. I know many of you think our galaxy is the only one, but it looks like that's just not so. This means the universe is a lot bigger than we thought."

______________ **4.** "I prefer the theory of the sun-centered universe over other theories. The telescope has helped me to discover that the planets are not just dots of light, but physical bodies like the Earth."

______________ **5.** "After several years of very precise observations, I conclude that our universe is Earth-centered. The sun and the moon revolve around the Earth, while the other planets revolve around the sun."

______________ **6.** "For centuries people have been thinking that the Earth is at the universe's center, but I'm certain that the sun is at its center. I am certain that the planets orbit the sun."

______________ **7.** "I do not agree with my mentor's theory that the sun revolves around the Earth. I have used his precise data to propose another theory in which all of the planets revolve around the sun in elliptical orbits."

Name: ____________________ Class: ________________ Date: ________ ID: A

Chapter 18

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following types of electromagnetic radiation is blocked by the Earth's atmosphere?
a. X rays
b. microwaves
c. infrared light
d. visible light

____ 2. Why do astronomers put telescopes in space?
a. to reduce air pollution
b. to get closer to objects in space
c. to avoid interference from the Earth's atmosphere
d. to avoid noise pollution

____ 3. What evidence shows that the universe is expanding?
a. Galaxies are moving closer together.
b. Galaxies are moving apart.
c. The number of galaxies is growing.
d. Galaxies are getting bigger.

____ 4. What is a constellation?
a. a region of the sky
b. a group of stars
c. a star pattern
d. a galaxy

____ 5. What does a telescope collect from space and focus for closer observation?
a. magnetic particles
b. electromagnetic radiation
c. lenses
d. wavelengths

____ 6. What is the imaginary sphere, created by scientists, that surrounds the Earth?
a. a zenith
b. a celestial sphere
c. an astrolabe
d. an ecliptic

____ 7. How did Hubble tell the universe was expanding?
a. Galaxies were moving away from each other.
b. Galaxies were moving toward each other.
c. Galaxies were getting bigger.
d. The number of galaxies was increasing.

____ 8. Which of the following indicates the universe is expanding?
a. a growing celestial sphere
b. an increase in the number of constellations in the sky
c. the discovery of other galaxies
d. observations of redshift

____ 9. Where do scientists put telescopes to avoid interference from Earth's atmosphere?
a. in deserts
b. in valleys
c. in space
d. by cities

____ 10. What is an imaginary point directly above an observer's head?
a. celestial sphere
b. zenith
c. right ascension
d. altitude

Name: ____________________ ID: A

____ 11. Which of the following is NOT a type of electromagnetic radiation found on the electromagnetic spectrum?
a. microwave
b. visible light
c. radio wave
d. ocean wave

____ 12. How does the Earth's atmosphere affect starlight?
a. It blocks it.
b. It stretches it.
c. It causes it to shimmer and blur.
d. It causes it to change colors.

____ 13. Which of these would be shorter if Earth rotated faster?
a. years
b. months
c. weeks
d. days

____ 14. The vernal equinox is used to establish a star's
a. zenith.
b. distance from the Earth.
c. declination.
d. right ascension.

____ 15. Copernicus's theory was not accepted when he first proposed it because he stated that the sun was
a. the center of the universe.
b. an average star.
c. a source of energy.
d. about 93 million miles away.

____ 16. An X-ray telescope is NOT used on Earth because X rays are
a. blocked by the Earth's atmosphere.
b. destroyed by the Earth's magnetic field.
c. very dangerous to humans.
d. distorted by the Earth's winds.

____ 17. Which of the following scientists thought the Earth was at the center of the universe?
a. Ptolemy
b. Hubble
c. Newton
d. Copernicus

____ 18. What blocks most types of electromagnetic radiation?
a. the Earth's atmosphere
b. the sun's atmosphere
c. starlight
d. sunlight

____ 19. What did redshift tell Hubble about the universe?
a. The universe is getting smaller.
b. The universe is getting larger.
c. The universe is getting colder.
d. The universe is getting redder.

____ 20. How long does Earth take to orbit once around the sun?
a. day
b. week
c. month
d. year

____ 21. How long does Earth take to rotate once on its axis?
a. day
b. week
c. month
d. year

____ 22. About how long does the moon take to orbit the Earth?
a. day
b. week
c. month
d. year

____ 23. Which of the following is NOT found on the electromagnetic spectrum?
a. gamma ray
b. X ray
c. ultraviolet light
d. black hole

Completion
Complete each statement.

24. A phenomenon in which sound seems to increase or decrease in relation to the direction it is moving is the ____________________.

25. An effect in which a star or galaxy appears to move quickly away from an observer is called ____________________.

26. When a star or galaxy appears to move quickly toward an observer, an effect called ____________________ occurs.

27. A nonoptical telescope that detects X-rays is the ________________________.

28. Stars that can be seen in all seasons and that never set are ____________________.

Use the terms from the following list to complete the sentences below.

altitude
ecliptic
month
right ascension
refracting telescope
declination
constellation
reflecting telescope
year

29. Ursa Minor is an example of a(n) ____________________.

30. An instrument that uses a mirror to gather and focus light is a(n) ____________________.

31. The angular distance between a star and the horizon is the star's____________________.

32. The apparent path of the sun across the celestial sphere as seen from Earth is called the ____________________.

33. One can tell how far north or south an object is from the celestial equator by the object's ____________________.

34. The amount of time the moon takes to orbit the Earth is roughly a(n) ____________________.

Use the terms from the following list to complete the sentences below.

zenith	**horizon**
constellation	**celestial sphere**

35. An imaginary sphere that surrounds the Earth is the ____________________.

36. The line where the sky and Earth appear to meet is the ____________________.

37. An imaginary point directly above an observer's head is a ____________________.

38. A region of the sky with distinct star patterns is a ____________________.

Short Answer

39. What advantage did Galileo have over Ptolemy in understanding the structure of the universe?

40. What would it mean about the size of the universe if the galaxies were moving toward each other instead of apart from each other?

Matching

Match each item with the correct statement below.

a.	Galileo Gallilei	f.	Edwin Hubble
b.	Tycho Brahe	g.	Ptolemy
c.	Johannes Kepler	h.	day
d.	Sir Isaac Newton	i.	year
e.	Copernicus	j.	month

____ 41. showed that planets and moons stay in orbit due to gravity
____ 42. was one of the first persons to use a telescope to observe celestial bodies
____ 43. developed a theory of a sun-centered universe
____ 44. stated that planets move in elliptical orbits around the sun
____ 45. used a mural quadrant to measure the positions of planets and stars
____ 46. developed a theory of an Earth-centered universe in 140 CE
____ 47. proved the existence of galaxies other than the Milky Way
____ 48. the time required for the Earth to orbit once around the sun
____ 49. roughly the amount of time required for the moon to orbit once around the Earth
____ 50. the time required for the Earth to rotate once on its axis

Name: ______________________ ID: A

Match each item with the correct statement below.

a. electromagnetic spectrum
b. telescope
c. reflecting telescope
d. refracting telescope

____ 51. uses mirrors to gather and focus light
____ 52. all of the frequencies or wavelengths of electromagnetic radiation
____ 53. uses lenses to gather and focus light
____ 54. collects electromagnetic radiation from the sky and focuses it for better observation

Match each item with the correct statement below.

a. altitude
b. horizon
c. light-year
d. zenith
e. vernal equinox
f. celestial sphere

____ 55. the sun's location on the first day of spring
____ 56. an imaginary sphere that surrounds the Earth
____ 57. the distance that light travels in one year
____ 58. the line where the Earth and sky appear to meet
____ 59. the angle between an object in the sky and the horizon
____ 60. an imaginary point in the sky directly above an observer on Earth

Match each item with the correct statement below.

a. Kepler
b. Hubble
c. Newton
d. Galileo

____ 61. showed that gravity keeps planets in orbit
____ 62. showed that planets have elliptical orbits
____ 63. proved there were many galaxies
____ 64. one of the first scientists to use a telescope