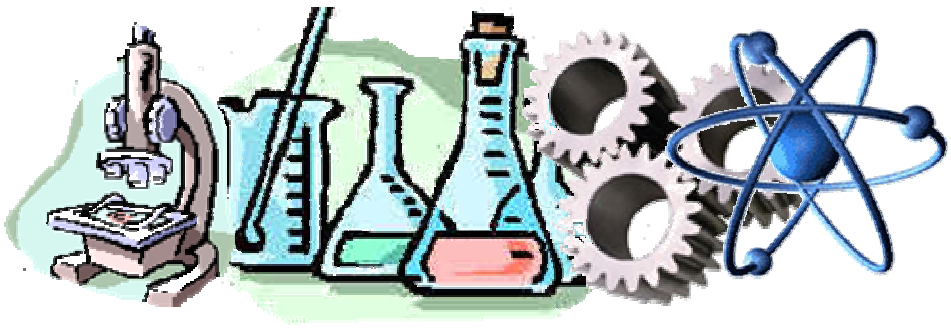
Project EASE

(Effective and Alternative Secondary Education)

INTEGRATED SCIENCE I



MODULE 18

BUREAU OF SECONDARY EDUCATION

Department of Education
DepED Complex, Meralco Avenue
Pasig City

Module 18
Beyond the Solar System

What this module is about

This module presents information on some of the deep-sky objects we love to see in the night sky, the stars. The activities presented here are designed to stimulate your interest to explore these jewels of the night sky. Come with me and have fun learning the following lessons:

- **Lesson 1 - The Glittering Star**
- **Lesson 2 - The Star Sign**

What you are expected to learn

After going through this module you should be able to:

1. explain the distance of stars from Earth in terms of appropriate units;
2. explain the life cycle of a star; and
3. construct a constellation.

How to learn from this module

I know you are excited to learn the lessons just as I am but remember these tips to help you achieve the objectives of this self-learning kit.

1. Read instructions carefully.
2. Follow instructions carefully.
3. Answer the pretest before you start the lesson.
4. Observe the time limit to finish the module.
5. Take note and record points for clarifications.
6. Try to achieve at least a 75% level of proficiency in the tests.
7. Work diligently and honestly.
8. Answer the posttest honestly.

What to do before (Pretest)

Multiple Choice: Write the letter of the best answer before each number.

___1. How far away in light years is our nearest star, Proxima Centauri?
   a. 2.2
   b. 4.3
   c. 5.5
   d. 6.0

___2. What color is the hottest star?
   a. red
   b. blue
   c. white
   d. yellow

___3. What element is the fuel for main sequence stars?
   a. carbon
   b. helium
   c. oxygen
   d. hydrogen

___4. The star is considered old when
   a. all its fuel is gone
   b. it becomes black hole
   c. it has reached the giant phase
   d. it has reached the protostar phase

___5. On H-R diagram, most stars are
   a. giants
   b. supergiants
   c. white dwarfs
   d. main-sequence

___6. What process releases a tremendous amount of heat, causing a protostar to become a main-sequence star?

   a. nuclear fision
   b. nuclear fusion
   c. star explosion
   d. nitrogen combustion

___7. Most astronomers agree that the stars are born within huge clouds of dust and gases called
   a. sun
   b. pulsars
   c. auroras
   d. nebulae

___8. The actual amount of light or brightness given off by a star is called
   a. parallel shift
   b. apparent magnitude
   c. absolute magnitude
   d. none of the above

___9. Most of the core of a red giant is made of
   a. iron
   b. helium
   c. methane
   d. hydrogen

___10. Which of the following units is used in measuring the distance of a star from the earth?
   a. mile
   b. inch
   c. kilometer
   d. light year

___11. Which of the following statements is true?
   a. The higher the magnitude number, the brighter the star
   b. The lower the magnitude number, the dimmer the star
   c. The lower the magnitude number, the brighter the star
   d. All statements are true

___12. Which of the following is the correct speed of light?
   a. 300,000 kilometers
   b. 9,460,800,000,000 kilometers
   c. 300,000 kilometers per second
   d. 9,460,800,000,000 kilometers per second

___13. What determines the fate of a dying star?
   a. its mass
   b. its size
   c. its color
   d. its temperature

___14. Which of the following describes the constellation Ursa Major?
a. lion
b. fish
c. dragon
d. big bear

___15. Which of the following best describes a black hole?
a. a place where angels meet
b. the darkest and coolest place in space
c. the outermost boundary of the universe
d. a region in space where light cannot escape

Key to answers on page 19

Lesson 1 The Glittering Star

Twinkle twinkle, little star,
How I wonder what you are!
Up above the world so high,
Like a diamond in the sky.

Tis your bright and tiny spark,
Lights the trav'ller in the dark:
Tho' I know not what you are
Twinkle, twinkle, little star.

When was the last time you've recited this poem? Though little is known about these glittering objects in the sky, that has not stopped poets and writers from writing beautiful poems and stories about these deep-sky objects.

What is a star?

A star is an enormous glowing ball of hot gas. There are billions of stars contained in the galaxies of the universe. The Milky Way is the galaxy where our solar system belongs. All the individual stars you see in the night sky are members of our galaxy.

A star is born

Maybe you are wondering how a star is formed. Aside from billion of stars, all galaxies contain huge clouds of gas and dust called **nebulae**. According to scientists, it is in a nebula where a star is born.

The formation of a star starts when hydrogen gas is pulled into the spinning clouds of nebula. As the clouds spin, the atoms of the hydrogen gas collide. With this, friction heats other gases in the cloud and the temperature in the center of the cloud rises. This give rise to a **protostar**. The protostar starts to expand and contract. The temperature reaches a point where nuclear fusion begins to take place. **Nuclear fusion** is the reaction that converts hydrogen atoms into helium atoms releasing a tremendous amount of heat, causing the gas to glow. When the mass at the center becomes stable, it now becomes the main-sequence star that will continue to glow for millions or billions of years.

Did you know?
To become a true star, Protostar must be at least 80 times as massive as Jupiter.

How long will stars live? Do they get old?

After perhaps billions of years, the nuclear fuel of a star, which is the hydrogen, runs out. When this happens the star expands while the core contracts. The star now begins to glow red.

The star is considered old when it has reached the red giant phase that eventually explodes and turns into a dim, cool object. The collapse and explosion of a not so big star is called **nova**, while the explosion of a massive star is called **supernova**. However, some red giant stars undergo a nonexplosive fashion. These stars become **planetary nebulae**.

Then what happens next?

Well, the destiny of a star depends on how massive it is. When the last of the hydrogen gas in the outer shell of a star have a mass equal to or less than the mass of the sun, it becomes a **white dwarf**. A white dwarf star is extremely dense and shines with a white, hot light. When a star that has a mass equal to 2 or 3 times the mass of the sun runs out of hydrogen, it becomes a **neutron star**. A neutron star is an extremely dense star composed of tightly packed neutrons formed by the welding together of protons and electrons. The more massive the star is, the more dramatic its end will be. A massive star that has a mass equal to 3 to 4 times the solar mass becomes a **black hole** when no nuclear fuel is available to support its core. A black hole is a region in space where light cannot

escape. According to studies made, a black hole swallows any matter or energy that comes near it.

Why do stars twinkle?

Do you know that stars do not twinkle? They seem to twinkle when we see them from the earth's surface. The light of the stars is bent or refracted as it travels through the thick layers of the earth's atmosphere. This bending of light results in the twinkling of the stars.

Why do you not see stars in the daytime?

Think twice! During daytime we cannot see any star other than the Sun. Yes, our own sun is a star. This is the nearest and brightest star to earth. This is the only star we can see during the day. As the Sun lits up the sky, more light is coming from the sky than from the stars. But though you can't see other stars during the day, it does not mean they are not there.

Other than the sun, what star is nearest to earth?

Other than the sun, the Proxima Centauri is the nearest star to earth. It is 4.3 light years away from earth. A **light year** is the standard unit of distance for deep sky objects. It is the distance light travels in a year, or about 10 trillion kilometers.

To give you an idea of how far Proxima Centauri is, let us say you will go there with a speed of 300, 000 kilometers per second, which is the speed of light. At this speed, it will take you more than 4 years and 3 months to reach the place.

Listed below are some stars with their distances from earth.

Star Name	**Distance from earth**
Sirius	8.6 light years
Vega	26 light years
Betelguese	300 light years
Deneb	400 light years
Rigel	540 light years

How bright are the stars?

Star brightness is described in terms of **magnitude**. The brightness of a star as seen from earth is called **apparent magnitude**, while its true brightness is called **absolute magnitude**. The magnitude sequence for stars starting with the brightest is … -2, -1, 1, 0,1, 2, 3, 4, 5, 6, 7, magnitude…etc. The brightest stars have the largest negative numbers. Dimmer stars are positive numbers. For

example, a star of magnitude 1 is brighter than a star of magnitude 2. While a star of magnitude -2 is brighter than a star of magnitude -1.

The table below shows the magnitude of some stars.

Star Name	**Magnitude**
Sirius	-1.47
Vega	-0.00
Rigel	0.15
Betelguese	0.43
Deneb	1.25

Do you know the color of the stars?

Looking at the sky on a clear night, you might notice that stars have different colors. Some stars look red, while most look whitish or bluish. You may use binoculars to see the colors more clearly.

What does the color of the stars tell us?

Did you know that the color of the star indicates its temperature? Astronomers can determine the surface temperature of a star by measuring its color. They use different methods in determining the temperature of stars. One method is the use of an instrument called **photometer**. A photometer consists of three filters that transmit light in three different wavelength ranges. Then the scientists compare the two neighboring wavelength bands to determine which is brighter and they convert the color relationships to temperature. Blue stars are hotter than red stars. Rigel is an example of a bright blue star while Betelguese is a bright red star.

How hot is a star?

Always remember that the temperature of a star depends on its original mass when it was formed. In general, the more massive a star is, the hotter its surface. Stars have temperatures between about 2,600 degrees Kelvin and 50,000 degrees Kelvin. Our sun has a surface temperature of 5,780 degrees Kelvin.

One of the most important tools of astronomers is the Hertzsprung-Russel diagram or simply called H-R diagram. It was developed by a Danish astronomer Ejnar Hertzsprung and an American astronomer Henry Norris Russel. The H-R diagram is a plot of different stars indicating their brightness versus their temperatures.

What you will do

Activity 1.1

HOW OLD ARE THEY?

Part 1. Direction: Rank each of the following pictures by age, going from youngest to oldest. Put a 1 in the blank by the picture you think is the youngest person, a 2 in the blank by the second youngest, and so on.

_____

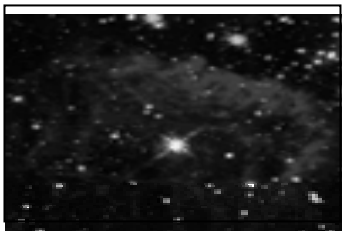
_____

_____

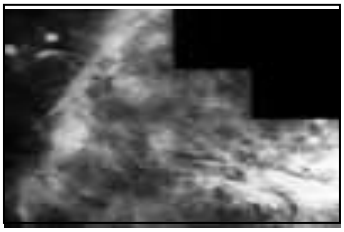
_____

_____

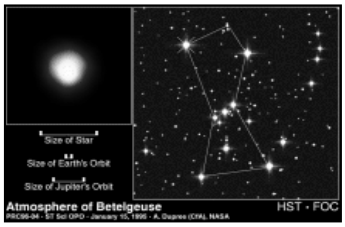
Part 2. Direction: Rank each of the following pictures of BIG stars from birth formation to stellar death. Put a 1 in the blank by the picture you think is the youngest star, a 2 in the blank by the second youngest, and so on.



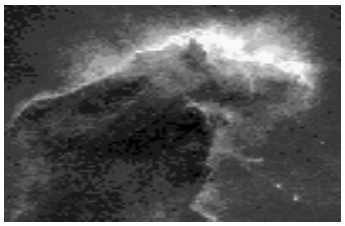
Large star. A celestial mammoth that releases up to 10 million times the power of the sun _____



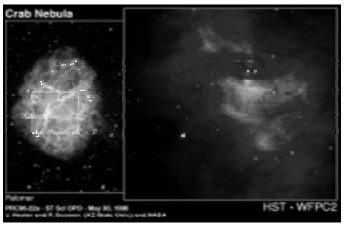
Orion Nebula surrounded by disk of dust and gas _____



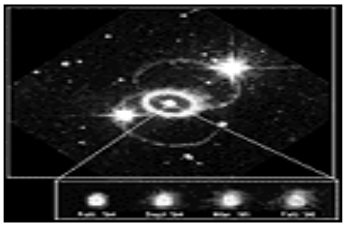
Betelguese star. A red supergiant. _____



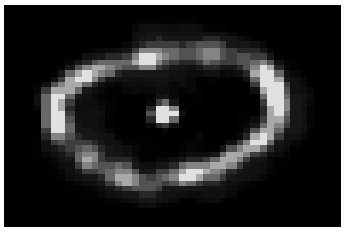
Embryonic star accumulates more mass from the surrounding. _____



Crab Nebula the remains of an exploding star. _____



Supernova blast. _____



Nova Cygni ballooning bubble of gas blasted off a star. _____

Question:
What was your basis of classifying the pictures (persons and stars) by age? Explain the life cycle of a star.

SOURCE:
http://btc.montana.edu/ceres/html/LifeCycle/images/M16Eagle.jpg

Key to answers on page 19

What you will do

Activity 1.2 Glittering Stars

This craft makes a beautiful picture of a night sky. The stars in our galaxy are represented by the glitter (or sand).

Materials needed:

- black construction paper
- pencil or white crayon
- glue
- glitter (or sand)
- old newspapers to work on

Procedure:

A. Work on some old newspaper. On the black construction paper, using a pencil or crayon, draw some sketches of your own stars. Some are big and some are small. Some stars are scattered throughout the construction paper, and some are clustered. The black background represents the night sky.

B. Put glue along the lines of your stars.

C. Sprinkle glitter (or sand) on each star. You may use different colors of glitters for each star. Tilt the paper onto some newspaper to shake off the loose glitter (or sand).

What you will do

Activity 1.1

How fast is light?

1. Scientists use a unit called light year to measure really long distances. Light travels at 186,000 miles per second (300,000 kilometers per second), therefore, a **light second** is 186,000 miles (300,000 kilometers). A light year is the distance that light can travel in a year. Calculate the exact number of miles in a light-year?

_____

_____

_____

2. Suppose the fastest spacecraft travels at 300, 000 kilometers per second. How long would it take such a spacecraft to reach Sirius, which is 8.6 light years away Earth?

_____
_____
_____
_____
_____

Key to answers on page 19

What you will do

Self-Test 1.1

Answer the following questions

1. Why are stars hot and bright?
2. Which one is brighter, a magnitude of 10 star or a magnitude of 0 star?

Key to answers on page 20

Lesson 2 Star Sign

Have you gone one night on a stargazing session? If you have, you must have seen patterns in the sky that look like a lion or a fish. Have you wondered what they are? You are correct! Those are special groups of stars known as constellations.

What is a constellation? Who discovered the constellation?

A constellation is the name given by our ancestors to special groups of stars. Constellations are invented rather than discovered. Different cultures have made up different constellations based on their interpretations of the images they see in the sky.

Why would people want to invent constellations?

Constellations were created to help our ancestors, even astronomers, remember stars. Long time ago, farmers used them as markers for seasons. When certain constellations appear in the sky, they would know when to begin planting or reaping.

Are you excited now to have another stargazing session? I'm sure you are! But before you go, as a beginner you have to bring with you a star map or sky map. The sky map shows the entire sky as viewed from a given location at a specified time and date. The sky map will tell you which of the constellations are visible to you at this time of year. But remember that constellations in the sky are not exactly the same as the constellations in your star map. You may ask your teacher where to get a copy of a sky map for the specific time and date you want. I'm sure she is willing to help!

The Big Dipper or the Great Bear is one of the most well known star groups. Actually, the Big Dipper is not really a constellation, but an asterism. An **asterism** is a more recognizable part of a larger constellation. The Big Dipper is a part of Ursa major constellation.

Most of the constellations are visible to the naked eye under good weather conditions. However, if you are living in the city, the brightness of city light may not allow you to see all the stars. The use of binoculars will make the stars look more impressive.

Once you have with you a copy of a sky map, with or without binoculars, you can now look for a good stargazing place. The city is still a good place to view the sky. Since only the brighter stars can be seen, you will be able to find the constellations easily.

If you think you are having difficulty searching for star patterns then concentrate on the circumpolar stars because they are always above the horizon. They are called circumpolar because they appear to circle the north celestial pole every night. Take a look at these circumpolar stars.

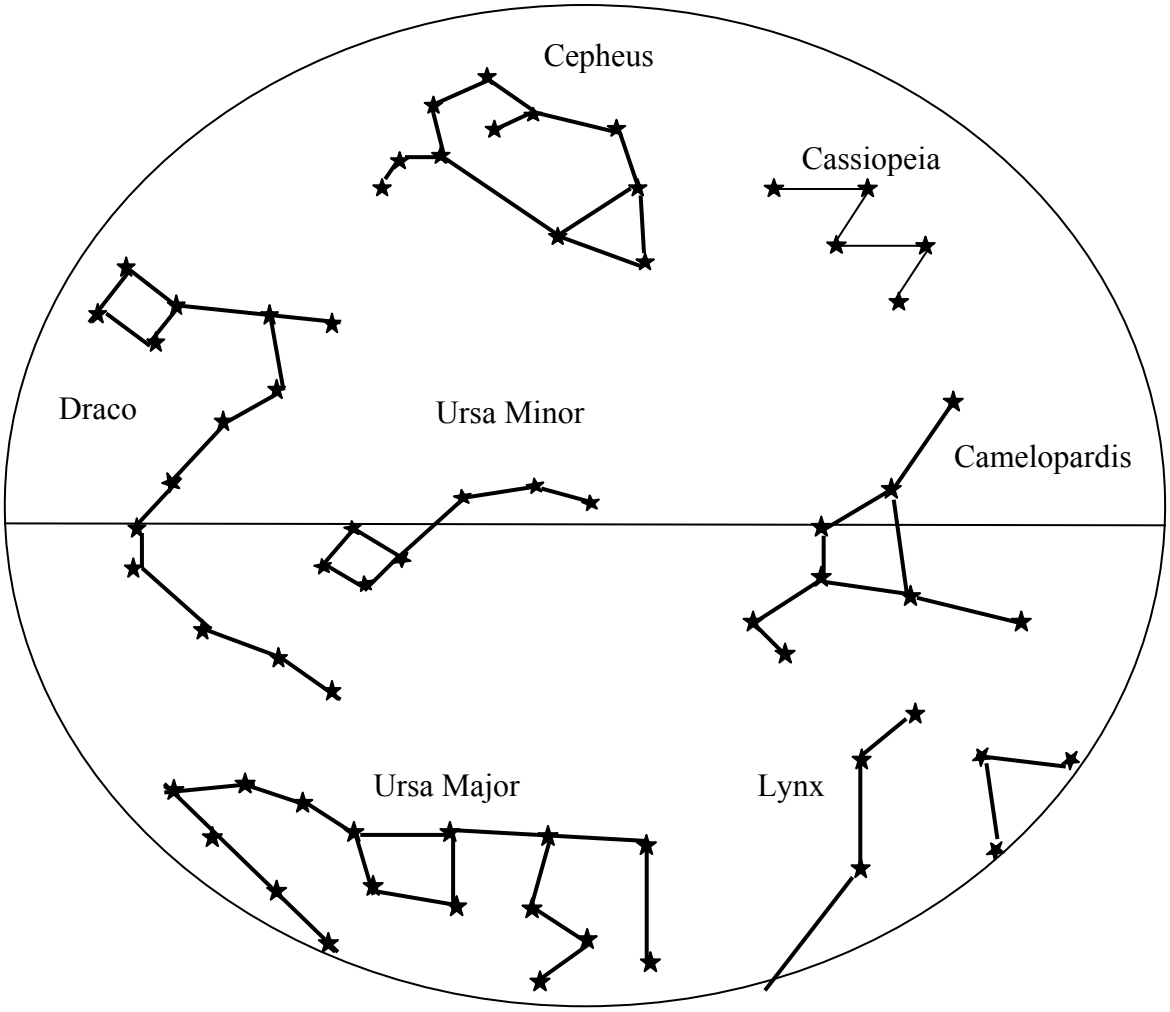


Figure .21 The Circumpolar Stars

How do you describe the Big Dipper? the little Dipper? Do they really look like bears? Look at the constellation Cassiopeia. Does it look like a queen's crown? How about Cepheus? Does it look like a king? Well, you can make your own constellation using your own imagination! Good luck and have some fun!

What you will do

Activity 2.1 Zodiac Names

The zodiac names we use today are actually the names given to special star groups known as constellations. How many constellations can you correctly describe?

Place the letter of the zodiac names in Column I that corresponds to the given constellations in Column II.

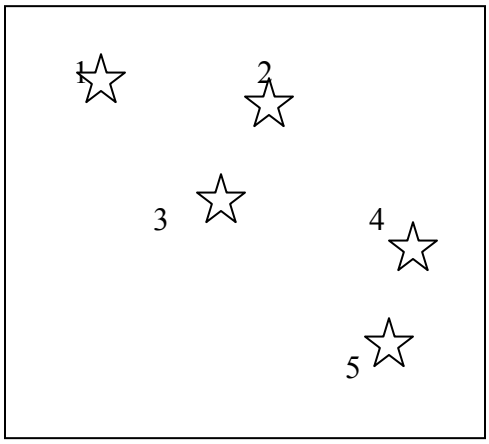
Column I Zodiac Names	**Column II** Constellation
A. Leo	____ The Crab
B. Aries	____ The Goat
C. Orion	____ The Bull
D. Libra	____ The Twins
E. Draco	____ The Dragon
F. Taurus	____ The Archer
G. Pisces	____ The Fish
H. Cancer	____ The Lion
I. Gemini	____ The Ram
J. Aquarius	____ The Scales
K. Pegasus	____ The Hunter
L. Sagittarius	____ The Scorpion
M. Scorpius	____ The Great Bear
N. Ursa Major	____ The Winged Horse
O. Capricornus	____ The Water Carrier

Key to answers on page 20

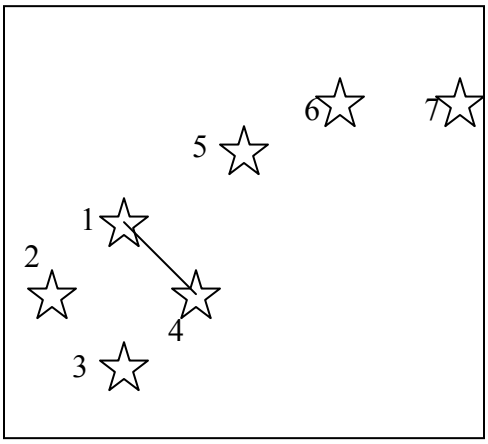
What you will do

Self-Test 2.1

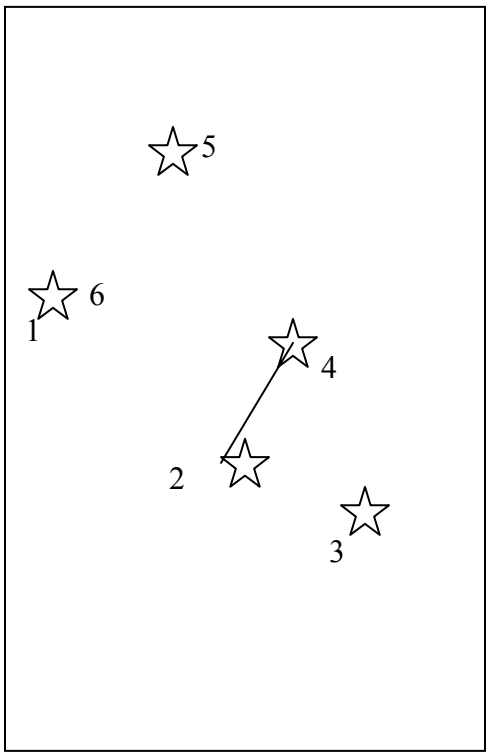
Connect the stars following the number sequence then name the constellation.



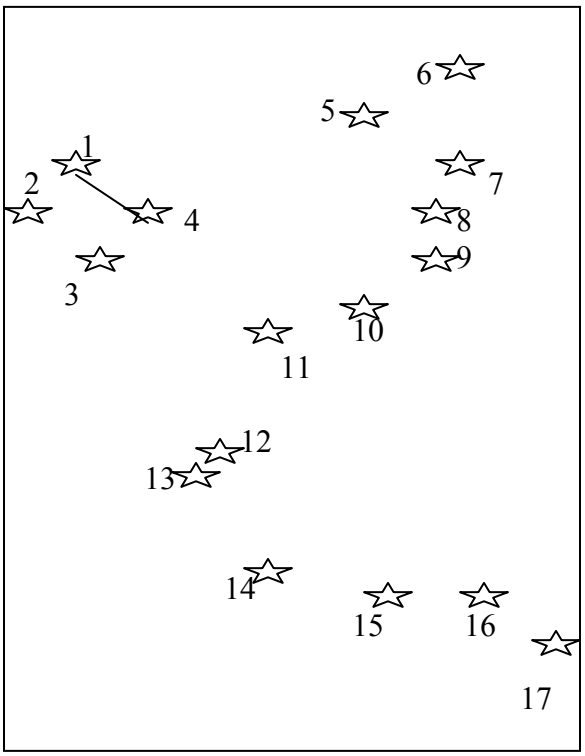
A. (The Queen) _____



B. (The Little Bear)_____



C. (The king) _____



D. (Draco) _____

Key to answers on page 21

Let's summarize

What are the things that you have learned from this module?

1. Scientists believe that all stars came from huge clouds of gas and dust called nebulae.
2. The nuclear fusion is the reaction that converts hydrogen atoms into helium atoms releasing a tremendous amount of heat, causing the star to glow.
3. A protostar is a very young star. It becomes a true star when nuclear fusion starts.
4. The star is considered old when it has reached the red giant phase that eventually explodes and turns into a dim, cool object.
5. The explosion of a massive star is called supernova.
6. The destiny of a star depends on how massive it is. It may become a white dwarf, a neutron star, or a black hole.
7. The color of the star indicates its surface temperature. Blue is the color of the hottest star.
8. A light year is the standard unit of distance for deep sky objects like stars. One light year is equal to 9,460,800,000,000 kilometers away from the earth. Other than the sun, Proxima Centauri is the nearest to earth.

Posttest

Multiple Choice: Write the letter of the best answer before each number.

Multiple Choice: Write the letter of the best answer on the space provided.

1. What color is the hottest star?
   a. red
   b. blue
   c. white
   d. yellow

2. How far away in light years is our nearest star, Proxima Centauri?
   a. 2.2
   b. 4.3
   c. 5.5
   d. 6.0

3. The star is considered old when
   a. all its fuel is gone
   b. it becomes black hole
   c. it has reached the giant phase
   d. it has reached the protostar phase

4. On H-R diagram, most stars are
   a. giants
   b. supergiants
   c. white dwarfs
   d. main-sequence

5. The actual amount of light or brightness given off by a star is called
   a. parallel shift
   b. apparent magnitude
   c. absolute magnitude
   d. none of the above

6. What process releases a tremendous amount of heat, causing a protostar to become a main-sequence star?

   a. nuclear fision
   b. nuclear fusion
   c. star explosion
   d. nitrogen combustion

7. What element is the fuel for main sequence stars?
   a. carbon
   b. helium
   c. oxygen
   d. hydrogen

8. Most astronomers agree that the stars are born within huge clouds of dust and gases called
   a. sun
   b. pulsars
   c. auroras
   d. nebulae

9. Which of the following statements is true?
   a. The higher the magnitude number, the brighter the star.
   b. The lower the magnitude number, the dimmer the star.
   c. The lower the magnitude number, the brighter the star.
   d. All statements are true.

10. Most of the core of a red giant is made of
   a. iron
   b. helium
   c. methane
   d. hydrogen

11. What determines the fate of a dying star?
   a. Its mass
   b. Its size
   c. Its color
   d. its temperature

12. Which of the following units is used in measuring the distance of a star from the Earth?
   a. mile
   b. inch
   c. kilometer
   d. light year

13. Which of the following best describes a black hole?
   1. a place where angels meet
   2. the darkest and coolest place in space
   3. the outermost boundary of the universe
   4. a region in space where light cannot escape

14. The star is considered old when
   a. all its fuel is gone
   b. it becomes black hole
   c. it has reached the giant phase
   d. it has reached the protostar phase

15. Which of the following describes the constellation Ursa Major?
   a. lion
   b. fish
   c. dragon
   d. big bear

Key to answers on page 20

Key to Answers

Pretest

1. B
2. B
3. D
4. C
5. D
6. B
7. D
8. C
9. B
10. D
11. C
12. C
13. A
14. D
15. D

Activity 1.1 How old are they?

(Part 1) Rank 2, 4, 1, 3, 5
(Part 2) Rank 3, 1, 4, 2, 7, 6, 5

The persons' age can be identified just by looking at persons' size and appearance. The age of the stars in the pictures can also be classified based on their sizes and general appearance. The descriptions and activities of each star are given to help you in classifying.

Activity 1.2 Students are free to do their own stars.

Activity 1.3 How fast is light

1. A light year is 5,865,696,000,000 miles (9,460,800,000,000 kilometers). That's a long way! (186,000 miles/second * 60 seconds/minute * 60 minutes/hour * 24 hours/day * 365 days/year = 5,865,696,000,000 miles/year)

2. It would take 8 years and 6 months to reach Sirius! (1 light year is 9,460,800,000,000 kilometers * 8.6 = 81,362,880,000,000 kilometers.

Use the formula time=distance/speed then, 81,362,880,000,000 kms/ 300,000 kilometers per second = 27,120,960,000,000 seconds.

Convert 27,120,960,000,000 seconds to hour, then to a day then to a year. The answer is 8 years and 6 months.

Self-Test 1.1

1. At the center of stars, the nuclear fusion, which converts hydrogen atoms into helium atoms, release a tremendous amount of energy that makes stars hot and bright.
2. The smaller the numerical magnitude, the brighter the object, thus a magnitude of 0 star is brighter than 10.

Activity 2.1 Zodiac names

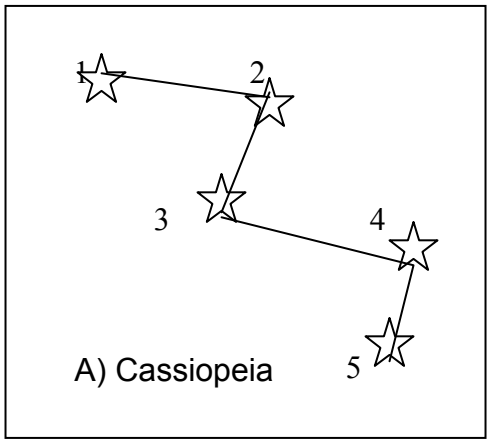
H	Crab
O	Goat
F	Bull
I	Twins
E	Dragon
L	Archer
G	Fish
A	Lion
B	Ram
D	Scales
C	Hunter
M	Scorpion
N	Great Bear
K	Winged Horse
J	Water Carrier

Posttest

1. B
2. B
3. C
4. D
5. C
6. B
7. D
8. D
9. C
10. B
11. A
12. D
13. D
14. C
15. D

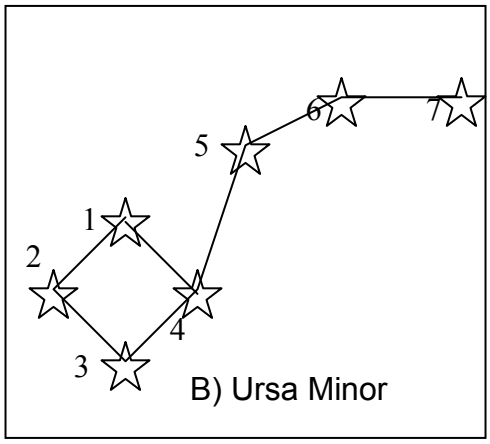
Self-Test 2.1

A. (The Queen Cassiopeia

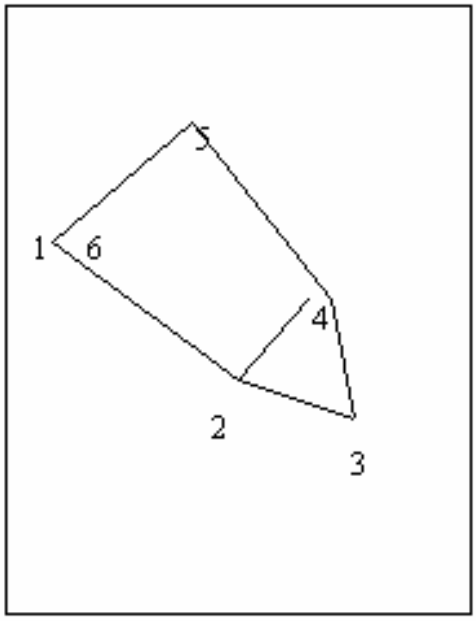


A) Cassiopeia

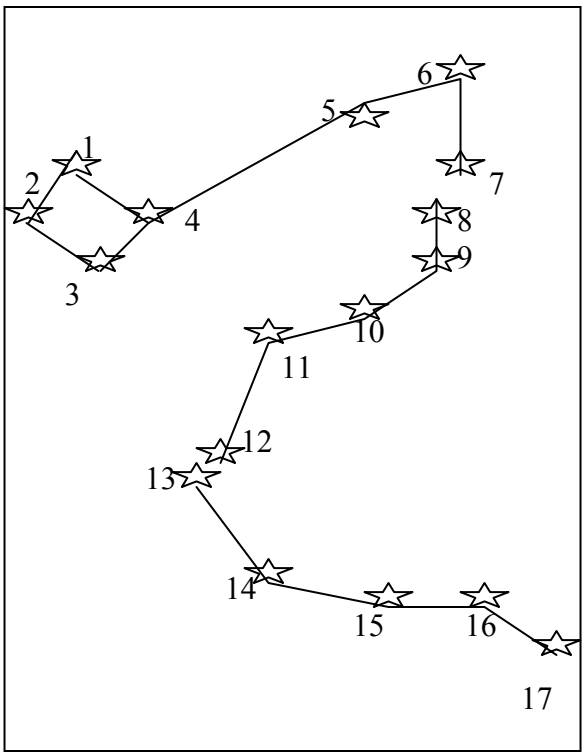
B. (The Little Bear) Ursa Minor



B) Ursa Minor



C) Cepheus



D) Dragon

-End of Module-

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