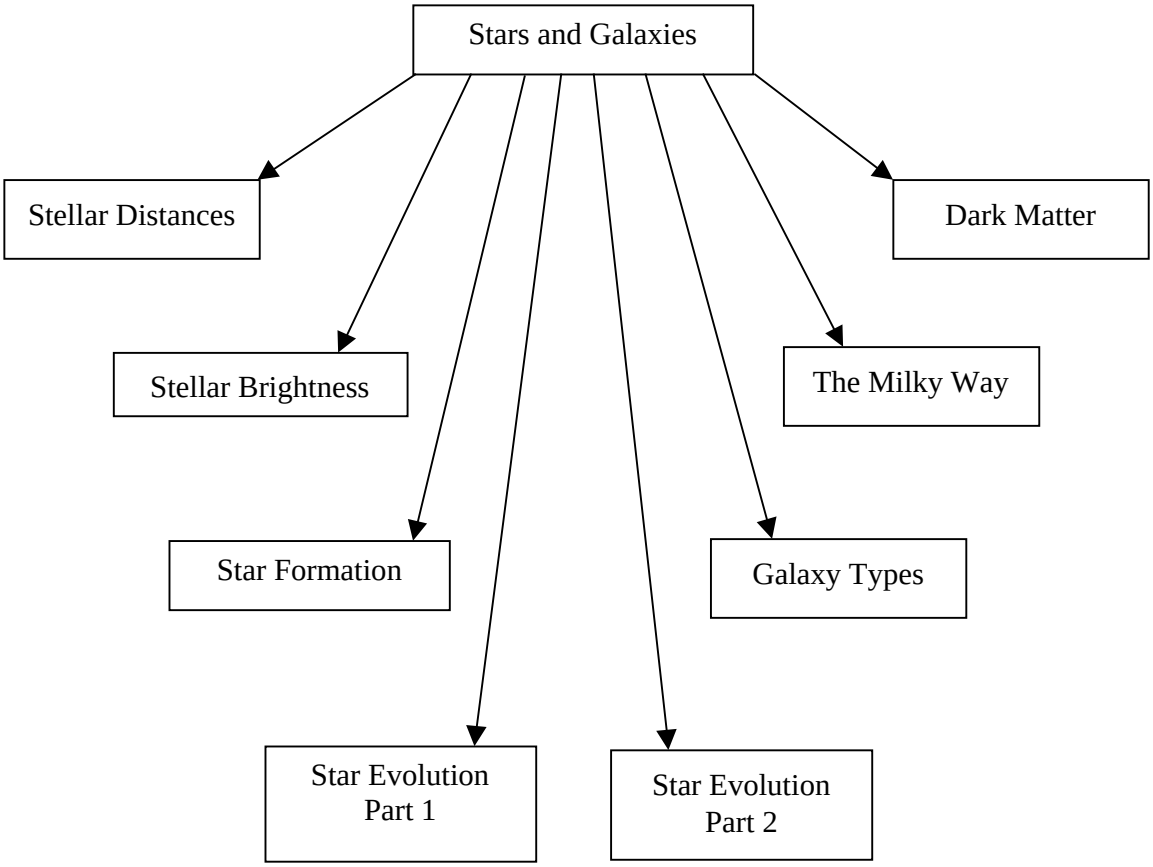
Stars and Galaxies
Stellar Distances
Stellar Brightness
Star Formation
Star Evolution Part 1
Star Evolution Part 2
Galaxy Types
The Milky Way
Dark Matter

Unit Title: Stars and Galaxies

Unit Goals: After completing this unit, the students will:
- understand what stars and galaxies are
- how gravity holds them together
- how stars and galaxies move and change with time
- gain some appreciation for the enormous size of both space and time that these objects occupy.

Grade Level: 9-12

Minimum time required for the unit: 10 instructional days (50 minute periods)

Concepts learned across all unit modules:
- Distance, scales and ratios
- Star brightness, lifetime and color
- Star mass and life stages
- Galaxy classification
- Energy source of galaxies
- Galactic evolution

Standards addressed by unit modules:

AAAS Project 2061 Benchmarks

- The stars differ from each other in size, temperature, and age, but they appear to be made up of the same elements that are found on the earth and to behave according to the same physical principles. Unlike the sun, most stars are in systems of two or more stars orbiting around one another. (4A, Grades 9-12)
- On the basis of scientific evidence, the universe is estimated to be over ten billion years old. The current theory is that its entire contents expanded explosively from a hot, dense, chaotic mass. Stars condensed by gravity out of clouds of molecules of the lightest elements until nuclear fusion of the light elements into heavier ones began to occur. Fusion released great amounts of energy over millions of years. Eventually, some stars exploded, producing clouds of heavy elements from which other stars and planets could later condense. The process of star formation and destruction continues. (4A, Grades 9-12)
- Increasingly sophisticated technology is used to learn about the universe. Visual, radio, and x-ray telescopes collect information from across the entire spectrum of electromagnetic waves; computers handle an avalanche of data and increasingly complicated computations to interpret them; space probes send back data and materials from the remote parts of the solar system; and accelerators give subatomic particles energies that simulate conditions in the stars and in the early history of the universe before stars formed. (4A, Grades 9-12)
- Mathematical models and computer simulations are used in studying evidence from many sources in order to form a scientific account of the universe. (4A, Grades 9-12)

National Science Education Standards
Content Standard A, Grades 9-12

- The origin of the universe remains one of the greatest questions in science.
- Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe.
- Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.

Maryland State Department of Education High School Science Core Learning Goals

- The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.
- The student will explain the role of natural forces in the formation of galaxies.
- The student will know how to use measurements of different orders of magnitude to construct an earth science model.

Technology needed in unit modules: Internet access for individuals or small groups, Microsoft PowerPoint, GalaxSee software.

Technology-enhance instructional strategies employed: Image presentation, parallel-problem solving, computer simulation, web-based research.

Title of Each Module:
Module 1-Stellar Distances
Module 2-Star Brightness
Module 3-Gravity and Fusion
Module 4-HR Diagram
Module 5-Types of Stars
Module 6-Types of Galaxies
Module 7-Our Galaxy
Module 8-Galactic Evolution

Unit Culminating Activity: Student Presentation: Our Constellation

Unit Author: John Hendrix

Module # 1

Module Title: Stellar Distances

Estimated time to complete: Two 50-minute class periods

Module objective: Students will be able to explain interstellar distances using scale models and use the light year as a unit of distance.

Concept(s) learned in this module: The distance between stars is very large. Distance units and measurement, scales and ratios.

Standards addressed in this module:

Maryland State Department of Education High School Science Core Learning Goals

- The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.
- The student will know how to use measurements of different orders of magnitude to construct an earth science model.

Technology-enhanced instructional strategies utilized in this module: Image Presentation, Information Searches, Parallel Problem Solving

MODULE OVERVIEW

Components	Brief description of module activities	Student Grouping	Materials/ Technology
Engagement	Warm Up Activities: Students are asked to speculate on how long it takes the light of the sun to get to Earth.	Individual or small groups	Overhead projector (OP) or PowerPoint (PP) to post the Warm Up questions.
Exploration	Discussion of student answers and computation of the distance to the sun in light-minutes. Construct a graph relating distance in km to light years. Problem-Solving Activity (PSA): How long would it take for a ship traveling at the same speed as Voyager II to get to the nearest star?	Individual or small groups	OP or PP to show images of the sun (http://umbra.nascom.nasa.gov/eit/eclipse_composite.html) and of a graph relating distance in km to distance in light minutes. Graph paper or software to produce a graph. Textbook or directed WWW search to answer Problem questions. Sites used: Voyager Mission Home Page (http://vraptor.jpl.nasa.gov/voyager/voyager.html)

			Stellar Distances (http://zebu.uoregon.edu/~js/ast122/lectures/lec09.html)
Explanation	Presentation and discussion of student work.	Individual or small groups	OP or monitor to show images of the sun and nearby stars. (http://www.honeylocust.com/Stars)
Extension	Follow-up research about the *Voyager* missions or other robotic missions of space exploration.	Small groups	Sites used: Voyager Mission Home Page,
Evaluation	Students will be evaluated based on their graph and their answers to the PSA.	Individual (all students submit their own work and answers based on their collaboration)	Rubrics for graphing and for PSA.

Expected module outcomes: Students will collaborate to produce a graph relating light years to kilometers and answer questions related to the Problem-Solving Activity. From this collaboration, they will be able to meet the module objectives.

Performance-based assessment of module outcomes: Students will be able to describe the enormous distances between stars as shown by their work on the PSA.

Module #2

Module Title: Apparent and Absolute Magnitude

Estimated time to complete: One 50-minute period

Module objective: Students will be able to describe the relationship between star brightness and distance from Earth.

Concept(s) learned in this module: Stars appear to have different brightness because some are, in fact, brighter and because they are at different distances from Earth.

Standards addressed in this module:

AAAS Project 2061 Benchmarks

- The stars differ from each other in size, temperature, and age, but they appear to be made up of the same elements that are found on the earth and to behave according to the same physical principles. Unlike the sun, most stars are in systems of two or more stars orbiting around one another. (4A, Grades 9-12)

Maryland State Department of Education High School Science Core Learning Goals

- The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.

Technology-enhanced instructional strategies utilized in this module: Image Presentation, Information Searches

MODULE OVERVIEW

Components	Brief description of module activities	Student Grouping	Materials/ Technology
Engagement	Students are shown some lamps of different brightness and asked some questions relating inherent brightness and distance.	Individual or small groups	Overhead projector (OP) or PowerPoint (PP) to post the Warm Up questions.
Exploration	Discussion of student answers and presentation of various images of star fields showing stars of different brightness. Activity: Students will make their own constellations by connecting bright stars with lines to form pictures of their own choosing.	Individual	OP or PP to show images of star fields (http://antwrp.gsfc.nasa.gov/apod/ap991211.html) Handout of Activity. (http://www.yarden.ac.il/bloss/IAS/unit1_7/firstlk1.htm)

Explanation	Presentation and discussion of student work, and of the constellations seen by the ancients.	Individual	Handout of constellations with explanation.
Extension	Description of absolute and apparent magnitudes. Students should understand that the dim and insignificant stars in the handout could be very bright and distant (and could even be galaxies) or very dim and nearby.	Individual	Sequence of images zooming into a dim "star" that is then revealed to be a galaxy. This can be accomplished with software such as Starry Night. (http://www.starrynight.com)
Evaluation	Students will be evaluated on the quality and creativity of their constellations.	Individual	Rubric (of student's design if desired)

Expected module outcomes: Students will gain further appreciation for the sun's position in space among the stars and how these are not all the same and are located at various distances from us.

Performance-based assessment of module outcomes: Students will be able to describe how some stars are dim and others bright and explain how their various distances from us influence how bright they look from Earth.

Module #3

Module Title: Gravity and Fusion

Estimated time to complete: One 50-minute period

Module objective: Students will be able to describe the relationship between gravity and nuclear fusion as these relate to star formation, and explain that stars are formed by the gravitational collapse of nebulae.

Concept(s) learned in this module: Stars are formed by the gravitational collapse of nebulae and undergo nuclear fusion at their cores, which is the energy source of all stars.

Standards addressed in this module:

AAAS Project 2061 Benchmarks

· On the basis of scientific evidence, the universe is estimated to be over ten billion years old. The current theory is that its entire contents expanded explosively from a hot, dense, chaotic mass. Stars condensed by gravity out of clouds of molecules of the lightest elements until nuclear fusion of the light elements into heavier ones began to occur. Fusion released great amounts of energy over millions of years. Eventually, some stars exploded, producing clouds of heavy elements from which other stars and planets could later condense. The process of star formation and destruction continues. (4A, Grades 9-12)

National Science Education Standards

Content Standard A, Grades 9-12

· Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.

Maryland State Department of Education High School Science Core Learning Goals

· The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.
· The student will explain the role of natural forces in the formation of galaxies.

Technology-enhanced instructional strategies utilized in this module: Image Presentation, Information Searches

MODULE OVERVIEW

Components	Brief description of module activities	Student Grouping	Materials/ Technology
Engagement	Warm-up activity and questions regarding the crushing of a styrofoam cup.	Individual or small groups	Overhead projector (OP) or PowerPoint (PP) to post the Warm Up questions, and small styrofoam cups for the first day.
Exploration	Discussion of student answers and presentation of various images of nebulae and regions of star formation. Use an inflated balloon to further illustrate the balance between gravity and nuclear fusion. Activity: A Human Nebula	Small groups	Overhead projector (OP) or PowerPoint (PP) to show the images and activity questions. Balloons.
Explanation	The sun formed from a cloud of dust and gas that collapsed and underwent nuclear fusion at its core. The greater the size of a star, the greater its gravity, the greater the energy released by nuclear fusion.	Small groups	Access to the internet: Fusion Animations (http://physics.hallym.ac.kr/education/oregon/textbook/energygen.html)
Extension	Research the history of the hydrogen bomb, or the different kinds of nebulae.	Small groups	Access to the internet. Possible sites:
Evaluation	Students will be evaluated on the quality of their answers.	Small groups.	Rubric (of student's design if desired)

Expected module outcomes: Students will discover that the spherical shape of stars is the result of a balance between gravity and nuclear fusion and that stars are formed from the gravitational collapse of large clouds of dust and gas.

Performance-based assessment of module outcomes: Students will be able to describe what nebulae are, what nuclear fusion is and how gravity holds stars together.

Module # 4

Module Title: The Hertzprung-Russell Diagram

Estimated time to complete: One 50-min class period

Module objective: Students will be able to describe the relationship between stellar mass, luminosity, temperature and "lifetime".

Concept(s) learned in this module: The size of a star determines its brightness and lifetime. The color of a star indicates its surface temperature.

Standards addressed in this module:

AAAS Project 2061 Benchmarks

- The stars differ from each other in size, temperature, and age, but they appear to be made up of the same elements that are found on the earth and to behave according to the same physical principles. Unlike the sun, most stars are in systems of two or more stars orbiting around one another. (4A, Grades 9-12)
- Mathematical models and computer simulations are used in studying evidence from many sources in order to form a scientific account of the universe. (4A, Grades 9-12)

Maryland State Department of Education High School Science Core Learning Goals

- The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.

Technology-enhanced instructional strategies utilized in this module: Image Presentation, Parallel Problem Solving

MODULE OVERVIEW

Components	Brief description of module activities	Student Grouping	Materials/ Technology
Engagement	Students are asked to speculate about the relationship between color and temperature.	Individual or small groups	Overhead projector (OP) or PowerPoint (PP) to post the Warm Up questions. Candles
Exploration	Discussion of student answers, including color and temperature in art where the relationship is opposite of that in physics. Problem Solving Activity (PSA): The HR Diagram	Individual or small groups	Internet access for PSA. HR Diagram Simulator (http://www.astro.ubc.ca/~scharein/a311/Sim/hr/HRdiagram.html)

Explanation	The evolution of a star is largely determined by its initial mass. Large stars burn their fuel fast and have short lives. Small stars burn fuel slowly and last a long time. The main sequence is the expected relationship between temperature and brightness.	Individual or small groups.	Use HR Diagram Simulator to illustrate answers to PSA.
Extension	Research the origin of the HR diagram.	Individual	Internet access
Evaluation	Students will be evaluated based on their answers to the PSA.	Individual or small groups	Evaluation rubric

Expected module outcomes: Students will be able to relate the initial mass of a star to its developmental stages and ultimate fate, especially as these relate to the sun.

Performance-based assessment of module outcomes: Students will be able to describe the relationship between stellar mass, luminosity, temperature and lifetime as shown by their work on the PSA.

Module #5

Module Title: Types of Stars

Estimated time to complete: One 50-minute class period

Module objective: Students will describe several types of stars and explain how the mass of a star largely determines its evolution.

Concept(s) learned in this module: Stars go through stages as they consume their nuclear fuel. The stages that a star will go through are largely determined by the mass of the star. Stars in all stages can be observed from Earth.

Standards addressed in this module:

AAAS Project 2061 Benchmarks

- On the basis of scientific evidence, the universe is estimated to be over ten billion years old. The current theory is that its entire contents expanded explosively from a hot, dense, chaotic mass. Stars condensed by gravity out of clouds of molecules of the lightest elements until nuclear fusion of the light elements into heavier ones began to occur. Fusion released great amounts of energy over millions of years. Eventually, some stars exploded, producing clouds of heavy elements from which other stars and planets could later condense. The process of star formation and destruction continues. (4A, Grades 9-12)
- Increasingly sophisticated technology is used to learn about the universe. Visual, radio, and x-ray telescopes collect information from across the entire spectrum of electromagnetic waves; computers handle an avalanche of data and increasingly complicated computations to interpret them; space probes send back data and materials from the remote parts of the solar system; and accelerators give subatomic particles energies that simulate conditions in the stars and in the early history of the universe before stars formed. (4A, Grades 9-12)

Maryland State Department of Education High School Science Core Learning Goals

- The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.
- The student will explain the role of natural forces in the formation of galaxies.

Technology-enhanced instructional strategies utilized in this module: Image Presentation, Information Searches, Parallel Problem-Solving

MODULE OVERVIEW

Components	Brief description of module activities	Student Grouping	Materials/ Technology
Engagement	Students are asked to speculate about the fate of stars.	Individual or small groups	Overhead projector (OP) or PowerPoint (PP) to post the Warm Up questions.
Exploration	Discussion of student answers and very brief overlook of stellar evolution. Problem Solving Activity (PSA): The Life Cycle of Stars	Individual or small groups	OP or PP to show some sample images of star types. Internet access for The Life Cycle of Stars (http://btc.montana.edu/ceres/html/stars1.html)
Explanation	Discussion of student answers and more detailed overlook of stellar evolution	Individual or small groups	Internet access.
Extension	Research white dwarfs and black holes.	Individual or small groups	Media center or internet access
Evaluation	Students will be evaluated based on their answers to the PSA.	Individual or small groups	Rubric, or student self-evaluation

Expected module outcomes: The students will discover that stars have a finite existence and that they go through stages analogous to biological, developmental stages.

Performance-based assessment of module outcomes: Students will be able to explain how the mass of a star largely determines how a star develops and how it will end its existence.

Module #6

Module Title: Types of Galaxies

Estimated time to complete: One 50-minute class period

Module objective: Students will be able to describe and classify the different types of galaxies.

Concept(s) learned in this module: There are many billions of galaxies in the universe, each made of hundreds of billions of stars. There are several different types of galaxies, classified according to their overall shape.

Standards addressed in this module:

National Science Education Standards

Content Standard A, Grades 9-12

- Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe.

Technology-enhanced instructional strategies utilized in this module: Image Presentation, Information Searches, Parallel Problem-Solving

MODULE OVERVIEW

Components	Brief description of module activities	Student Grouping	Materials/ Technology
Engagement	Students are shown a photograph of a galaxy and asked to speculate about what it is.	Individual or small groups	Overhead projector (OP) or PowerPoint (PP) to post the Warm Up questions.
Exploration	Discussion of student answers and assignment of Problem-Solving Activity: Galaxy Classification Activity	Small groups	OP or PP to show some sample images of our galaxy. Begin research at: Galaxy Classification Activity (http://btc.montana.edu/ceres/html/gal1.html)
Explanation	Discussion of student answers and description of how it was recognized that galaxies were "island universes"	Small groups	Internet access
Extension	Research the Andromeda galaxy and its eventual collision with the Milky Way.	Individual	Internet resources.
Evaluation	Students will be evaluated based on their answers to the PSA.	Small groups	Rubric, or student self-evaluation

Expected module outcomes: Students will discover that galaxies are absolutely enormous objects consisting of ridiculously large numbers of stars, and that we are also part of such an object.

Performance-based assessment of module outcomes: Students will be able to classify the various types of galaxies.

Module #7

Module Title: Our Galaxy

Estimated time to complete: Two or three 50-minute class period (one or two periods for research and preparation and one period for presentation)

Module objective: Students will be able to explain that the sun and its neighboring stars are part of an agglomeration of hundreds of millions of stars that we call the Milky Way.

Concept(s) learned in this module: The sun and its neighboring stars are gravitationally bound to, and orbit the center of a disk of stars 100,000 LY in diameter.

Standards addressed in this module:

Maryland State Department of Education High School Science Core Learning Goals

- The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.

Technology-enhanced instructional strategies utilized in this module: Image Presentation, Information Searches

MODULE OVERVIEW

Components	Brief description of module activities	Student Grouping	Materials/ Technology
Engagement	Students are asked to speculate about why there appears to be a nebulous swath of light in the night sky.	Individual or small groups	Overhead projector (OP) or PowerPoint (PP) to post the Warm Up questions.
Exploration	Discussion of student answers and assignment of research activity dealing with various mythical stories about the origin of the Milky Way.	Small groups	OP or PP to show some sample images of our galaxy. Begin research at: Celestial River (http://www.stryer.com) or at: Exploring Ancient Cultures (http://eawc.evansville.edu/index.htm)
Explanation	Students present their findings to the class	Small groups	PP for student presentations
Extension	Students can research the mythical origins of constellations and planets as seen by non-western cultures.	Individual	Internet resources.

Evaluation	Students will be evaluated by their peers on the quality of their presentations	Small groups	Rubric for presentation evaluation

Expected module outcomes: Students will be able to place the sun and solar system in the larger context of the galaxy.

Performance-based assessment of module outcomes: Student presentations

Module # 8

Module Title: Galactic Evolution and Dark Matter

Estimated time to complete: One 50-minute class period

Module objective: Students will explore the formation of development of galaxies through billions of years.

Concept(s) learned in this module: Galaxies are held together by gravity, change and interact with other galaxies, and may consist mostly of "dark matter".

Standards addressed in this module:

Maryland State Department of Education High School Science Core Learning Goals

- The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.
- The student will explain the role of natural forces in the formation of galaxies.

Technology-enhanced instructional strategies utilized in this module: Image presentation, computer simulation

MODULE OVERVIEW

Components	Brief description of module activities	Student Grouping	Materials/ Technology
Engagement	Students are asked to speculate about what holds galaxies together and why it is difficult to directly observe changes in them.	Individual or small groups	Overhead projector (OP) or PowerPoint (PP) to post the Warm Up questions.
Exploration	Students are introduced to *GalaxSee*, a computer simulation of point masses used to simulate the interaction of objects in a galaxy. Assignment of Problem-Solving Activity.	Individual or small groups	**GalaxSee Software** (http://www.shodor.org/master/galaxsee/software)
Explanation	Discussion of student observations and conclusions, as well as elaboration of the current views about the existence of dark matter.	Individual or small groups	GalaxSee Software, screenshots
Extension	Research on dark matter and its relevance to the possible fate of the universe.	Individual or small groups	Internet access

Evaluation	Students will be evaluated based on their answers to the PSA.	Individual or small groups	Evaluation rubric

Expected module outcomes: Students will realize that galaxies are not static object, but instead interact and change with time, albeit slowly, and that our understanding of the universe is far from complete.

Performance-based assessment of module outcomes: GalaxSee problem solving activity

Module 1 - Exploration
Problem-Solving Activity: Stellar Distances

Name _____
Group Name _____
Period _____

Now that you've made a graph relating distance in light years (LY) to distance in kilometers, you should be able to use this information to solve some problem related to interstellar travel.

Problem 1: If you want to walk from John F. Kennedy High School to the Washington Monument, how long will it take you? Make a list of the things that you have to know in order to answer this question, and make sure that everyone in your group is able to explain how to find the answer.

- List the things you need to know in order to answer the question:

- List the resources that you used to find the things that you needed to know:

- What is the approximate distance to between John F. Kennedy High School and the Washington monument in millimeters?

- Explain in words or with mathematics how your group found the answer to Problem 1:

- This is how long we think it will take to walk from John F. Kennedy High School to the Washington Monument:

Problem 2: If you want to travel from Earth to the nearest star, how long will it take you? For this question, let's assume that your space ship can travel as fast as the *Voyager I* space probe.

a) List the things you need to know in order to answer the question:

b) List the resources that you used to find the things that you needed to know:

c) What is the approximate distance to the nearest star in km?

d) Explain in words or with mathematics how your group found the answer to Problem 2:

e) How was this problem similar to Problem 1?

f) How was this problem different from Problem 1?

g) This is how long we think it will take to travel to the nearest star:

h) Why do you suppose that astronomers use the Light Year (LY) instead of kilometers or miles to describe interstellar distances?

Bonus Question: How fast do you think space ships would have to travel in order to make interstellar commerce and recreational travel feasible?

Module 1 - Evaluation

Graph from Scientific Data Performance List

Name_____
Date_____
Topic
Assessment

	Self	Teacher
1. I used an appropriate type of graph (bar graph, pictograph, stem-and-leaf, circle graph, line plot graph, etc.	_____	_____
2. The title of my graph clearly relates to the information displayed on the graph.	_____	_____
3. I used my data to choose an appropriate interval to number my x axis and y axis (2's, 3's, 5's, 10's, 100's, etc.)	_____	_____
4. When placing the numbers on my graph, I spaced them evenly.	_____	_____
5. I labeled all parts of my graph (units of measurement, x and y axis, columns, rows, etc.)	_____	_____
6. My set of data is plotted on the graph accurately.	_____	_____
7. My graph is clear and complete.	_____	_____

Scoring Tool

3	**7 out of 7 are checked**	**Graph is excellent.**
2	**6 out of 7 are checked**	**Graph is good.**
1	**5 out of 7 are checked**	**Graph is fair.**
0	**4 or less are checked**	**Graph is not acceptable.**

Teacher Comments:

Module 4 - Exploration
Problem-Solving Activity: The HR Diagram

Name _____
Group Name _____
Period _____

Now that you know something about the relationship between temperature and color, you are ready to explore more about the evolution of stars. Go to the HR Diagram Simulator at: http://www.astro.ubc.ca/~scharein/a311/Sim/hr/HRdiagram.html

This simulator shows information about the mass, temperature and luminosity (brightness) of stars and shows how stars change with time. Use the simulator to answer the following questions:

1. First, click the button labeled "100" one time to add one hundred stars to your diagram. The linear grouping that you see is called the main sequence.
   a) Generally speaking, how does the temperature of the blue stars compare to that of the red stars?
   b) Generally speaking, how does the luminosity of the blue stars compare to that of the red stars?

2. Now click on an individual blue star and write down its mass and main-sequence lifetime.

3. Do the same thing for a red star.

4. Explain, in general terms, what the relationship is between mass and main-sequence lifetime.

5. Now we are ready to start the simulation. Click on the button labeled "Evolve"
   a) Which stars leave the main sequence first?
   b) The stars change color as they leave the main sequence. What does this change indicate?
   c) Why do you think these changes take place?
   d) What do you suppose happens to stars after enough time goes by?

6. Start the simulation again, but this time click on an individual star and keep track of its luminosity as the simulation progresses.
   a) How does luminosity change as the star leaves the main sequence?
   b) Why do you suppose this is?

Module 7 – Exploration
Research Activity: Views of the Milky Way

Name _____
Group Name _____
Period _____

In this activity, you and your partners will create a PowerPoint presentation about how a human culture has viewed and explained the origin of the Milky Way. You will prepare your slide show today and present it to the class tomorrow.

- Your slide show will consist of 8 slides. The first step is to find out what you want to put on these slides, so go to the appropriate web site and learn about your assigned culture and how its people viewed the Milky Way.
- Once you've learned enough to convey an interesting story, make an outline of your slide show by making a story board on a folded piece of paper.
- Once your story board is ready, you can set out to turn it into a PowerPoint slide show. When you finish, save it to a disk using your Group Name, label it, and give it to me.
- Tomorrow, you and the members of your group will use the slide show to tell your story to the class.
- Be prepared for questions!

Module 8 – Exploration
Problem-Solving Activity: Galactic Evolution

Name _____
Group Name _____
Period _____

In this activity you will use a computer simulation to observe changes in a large collection of gravitationally-bound objects that represents a galaxy. The software that you will use is called *GalaxSee*.

Instructions:

1. Open the *GalaxSee* application.
2. Enter your name when prompted. Click enter.
3. On the screen, you will see a small box titled "Info". This box shows information about the Galaxy about to be displayed.
4. On the menu bar, click on "Galaxy" and go to "Galaxy Setup".
5. Make the distribution "Disk", the number of stars "512", the star mass "1", and the rotation factor "0".
6. Under "Galaxy", go to "Scale" and make sure it is "Galactic"
7. Again under "Galaxy", go to "New Galaxy"
8. There should be a galaxy displayed on your screen at this point.
9. You will notice that on the menu bar there are now more choices. Play around with the choices under "View" and "Action" so you can see what each choice does.
10. Whenever you are ready, go to "Galaxy" again and go to "Run" to begin the simulation.
11. You may not notice much at first, but your "Info" box will now be showing a number of changes, and you will notice the objects in your galaxy moving around.
12. You can grab and spin the galaxy with your mouse, but it won't continue to change until you make it come to a complete stop.
13. In the "Info" box under "simulation data" you will see a number next to MYR. That means millions of years. You are watching the galaxy change as millions of years go by right before your eyes.

Answer the following questions about your simulation:

1. In general, what happens to the object in your galaxy as time goes by?

2. How has the galaxy changed after 5 billion years? After 10 billion years?

3. How would you classify your galaxy according to its shape?

4. Do you think this is an accurate representation of a real galaxy? Why or why not?

5. Under “Galaxy”, go to “Model Settings” and change “Dark Matter” to the maximum amount. Under “Galaxy Setup”, change the rotation factor to the maximum. Then go to “New Galaxy” and run the simulation. Wait 13 billion years and describe how this galaxy is different from your first galaxy.

6. Go to “Galaxy Setup” and make changes to your galaxy. Write down your changes here (the changes will not take effect until you click “New Galaxy” and run it).

7. Describe your new galaxy after 5 billion years and after 10 billion years.

8. Is this galaxy a better or worse representation than your previous galaxies? Explain.

9. How were your simulations similar to a real galaxy?

10. Suggest some ways in which this simulation could be improved.

Unit Culminating Activity

Research and Presentation Project: Our Constellation

To complete this project successfully, you will have to:

- Present a poster showing your assigned constellation and the important object that form it, or are found within it. Your poster should be at least 36" x 24" and will be evaluated on creativity, neatness and quality.
- Describe in some detail the origin of the constellation's name and the mythical story that goes with it.
- Describe the location of the constellation in the sky and when it is visible during the year.
- List and describe the names, distances and types of stars that comprise the constellation.
- List and describe the names, distances and types of nebulae and galaxies that are found within the constellation.
- Prepare a written report that includes all of the above items as well as bibliographical information, and which must be typed.
- Prepare a PowerPoint presentation about your assigned constellation during which all of the members of your group will address the class. This presentation should last a maximum of 10 minutes and should NOT include ALL of the objects that you listed in your written report, but only the most important ones.
- Be ready to answer questions designed to test your knowledge of stars and galaxies as presented in class.

An outline of your written report is due on _____

An outline of your presentation is due on _____

Your written report and your presentation is due on _____

This project is worth _____ points.