Youngstown City Schools

Science - - PHYSICAL SCIENCE GRADE 9

Unit 9: THE UNIVERSE (3 WEEKS)

SYNOPSIS: Students investigate the history of the universe using current theories focusing on the Big Bang Theory, galaxies, and stars. Students design a travel brochure about a manned flight to a galaxy beyond our solar system and the Milky Way Galaxy. Students also design a lesson to instruct 5-6 grade students on the topic of galaxies. Finally, students prepare and deliver a news report announcing a new discovery.

STANDARDS

IV. THE UNIVERSE

A. History of the Universe

1. The" Big Bang" model is the broadly accepted theory for the origin and evolution of our universe.
    a. The contents of the known universe expanded explosively into existence from a hot, dense state 13.7 billion years ago (NAEP, 2009)
    b. 12 to 14 billion years ago, the portion of the universe seen today was only a few millimeters across (NASA).
2. Supporting evidence for the "Big Bang" theory include Hubble's law, red shift, or cosmic microwave background radiation.
3. Technology provides the basis for many new discoveries related to space and the universe, including - -
    a. visual radio and x-ray telescopes collect information across the entire electromagnetic spectrum
    b. computers are used to manage data and complicated computations
    c. space probes send back data and materials from remote parts of the solar system
    d. accelerators provide subatomic particle energies that simulate conditions in the stars and in the early history of the universe before stars formed

B. Galaxy Formation

1. After the Big Bang, the universe expanded quickly (and continues to expand) and then cooled down enough for atoms to form; gravity pulled atoms together into gas clouds that became stars, which comprised young galaxies.
2. A galaxy is a group of billions of individual stars, star systems, star clusters, dust and gas bound together by gravity.
3. There are billions of galaxies in the universe, and they are classified by size and shape.
    a. Milky Way is a spiral galaxy; has more than 100 billion stars and a diameter of more than 100,000 light years
    b. at the center of the Milky Way is a bulge of stars, from which are spiral arms of gas, dust and most of the young stars
    c. our solar system is part of the Milky Way galaxy
4. Hubble's law states that galaxies that are farther away have a greater red shift, so the speed at which a galaxy is moving away is proportional to its distance from the Earth.
5. Red shift is a phenomenon due to Doppler shifting, so the shift of light from a galaxy to the red end of the spectrum indicates that the galaxy and the observer are moving farther away from one another.

C. Stars

1. The formation of stars is described as stages of evolution.
    a. early in the formation of the universe, stars coalesced out of clouds of hydrogen and helium and clumped together by gravitational attraction into galaxies
    b. stars are classified by their color, size, luminosity and mass.
    c. Hertzsprung-Russell diagram are used to estimate the size of stars and predict how stars will evolve
        (1) most stars fall on the main sequence of the H-R diagram, a diagonal band running from the bright hot stars on the upper left to the dim cool stars on the lower right
        (2) a star's mass determines the star's place on the main sequence and how long it will stay there
    d. Patterns of stellar evolution are based on the mass of the star
        (1) stars begin to collapse as the core energy dissipates
        (2) nuclear reactions outside the core cause expansion of the star, eventually leading to the collapse of the star
2. Fusion occurs in stars and results in the formation of elements.
    a. when heated to a sufficiently high temperature by gravitational attraction, stars begin nuclear reactions, which convert matter to energy and fuse the lighter elements into the heavier ones
    b. these and other fusion processes in stars have led to the formation of all the other elements
    c. all of the elements, except for hydrogen and helium, originated from the nuclear fusion reactions of stars

LITERACY STANDARDS

RST.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

WHST.9 Draw evidence from informational texts to support analysis, reflection, and research.

MOTIVATION	TEACHER NOTES
1. Preassessment of **key terms** that will be used throughout the Unit: Big Bang, Galaxy, Red shift, Stellar evolution Electromagnetic spectrum, Light year, Space probes, Theory Fission, Milky Way, Star, Universe Fusion 2. Teacher asks students if the Universe looked the same way millions of years ago; if not, why? Ask students if the Universe will look the same millions of years from now; if not, why? Encourage the free exchange of ideas. 3. students view Carl Sagan video, Cosmos (#1- just the first 30 min. or so). www.**hulu.com/cosmos** **(note to teacher: there are several videos from which to choose; the same information is presented, but in different ways).** Students complete a graphic organizer provided by the teacher to show how the constantly changing universe affects planets, spacecraft that venture out into deep space, and a number of other natural phenomena. **(RST.2)** 4. Teacher conducts a discussion about how space debris presents a potential hazard to astronauts and spacecraft. See http://www.solarviews.com/eng/edu/spdebris.htm. Use a teacher demonstration or supervise a student demonstration of the penetrating power of a projectile with little mass but with high velocity (e.g., stab a raw potato with a large diameter plastic straw or blow hard into a pea shooter to accelerate the pea aimed at a piece of tissue paper taped to a cardboard frame). Students **read "Space Junk Littering Orbit; Might Need Cleaning Up."** Follow with a class discussion on the article and relate to recent artificial satellites that have fallen back to earth. 5. Teacher previews the culminating activities to be completed at the end of the unit. 6. Have students establish both academic and personal goals for this unit.	

TEACHING-LEARNING	TEACHER NOTES
1. Teacher describes theories other than the Big Bang about the origin of the **universe;** students take notes. **(IVA1)** 2. Teacher assigns reading, text or web page http://ssscott.tripod.com/BigBang.html, re: Big Bang Theory; students work in small groups, and one of the groups prepares a summary fo each of the following: (a) evidence for the theory, (b) importance of data that support expansion of the Universe; (c) stages of development; and d) evidence not supporting the theory. Each group presents summary to class, including a visual (diagram, poster, PowerPoint, etc.) on the groups assigned segment. **(IVA1a, b) (RST 9-10.2; WHST 9-10.9)** 3. Teacher discusses technology that was used to verify the Big Bang Theory. http://www.telescopes-astronomy.com.au/telescopes039.htm In pairs, students complete a listening/viewing guide. Technology provides basis for many new discoveries related to space and the universe. • visual radio and x-ray telescopes collect information across the entire electromagnetic spectrum	

TEACHING-LEARNING	TEACHER NOTES
• computers are used to manage data and complicated computations also to create simulations • space probes send back data and materials from remote parts of the solar system • measurement of cosmic background radiation • accelerators provide subatomic particle energies that simulate conditions in the stars and in the early history of the universe before stars, formed (**IV A1a, b)** 4. Teacher discusses the formation of a **galaxy - -** in terms of the origin and a description of its formation**;** relate to Big Bang. Students take notes about the physical characteristics of spiral, elliptical, and irregular galaxies; including the differences in size, shape, mass, color, stellar types, and amount of interstellar gas and dust. In small groups, students investigate at least three different examples of galaxies that have different shapes and investigate how the galaxy classification system of Edwin Hubble assigns galaxies to different groups according to their shapes. Students attempt to categorize unknown galaxies according to the Hubble classification descriptors. Students will complete a study sheet. This activity is online at http://cse.ssl.berkeley.edu/SegwayEd/lessons/classifying_galaxies/galaxy.htm. **(IV B1) (RST.2)** 5. Teacher reviews the electromagnetic spectrum in terms of visible light and related distance from the Earth. Students use a spectroscope to examine light coming through a spectrum to discover where the red light is. When the red light is very wide, the galaxy is moving away from Earth. Students read article on **Red Shift - - "Why is the Sky Dark at Night?"** to determine the relationship between color and distance of celestial bodies. Submit a written summary of the article. (RST #2) **(IV C1a) (RST.2; WHST.9)** 6. Teacher introduces the concepts of fission and fusion as related to star formation and eventual destruction; students take notes. **(IV C1a)** 7. Teacher shows students demonstration of "Celestia," a free real-time space simulation of the **universe** in three dimensions at http://www.shatters.net/celestia/. Teacher uses demonstration and guided instruction to show students how to navigate through the program. Students work in pairs to complete the navigation of the site. The teacher has students classify and categorize the information presented. Each group presents and explains its information to the class. Each pair prepares a profile of their star. Locate information related to distance from Earth, stage of development, color and brightness, diameters of stars, galaxy. **(IV C1b, c)** 8. Teacher demonstrates (using a flashlight and penlight) the differences between magnitude of a larger star and a smaller star and how their relative positions impact the magnitude of each. Teacher relates the demo to light curves as they would appear from plotting the data which refers to the developmental procedure students will do in the investigation "How Big Is That Star?" Students summarize their observations of the demonstration and make conclusions. **(IV C1b)** 9. Teacher introduces "How Big Is That Star" at http://imagine.gsfc.nasa.gov/docs/teachers/lessons/star_size/star_size.html. Students conduct the activities to: • explain the relationship between radius and mass among a list of stars • observe how a binary star system's orbit can cause changes in the observed brightness of the system (cause-effect graphic) **(IV C1b)** 10. Teacher divides class into groups and hands out sets of star data for 25 stars. To ensure	

TEACHING-LEARNING	TEACHER NOTES
that students understand what type of information is known about each star, teacher demonstrates the process using the sun. Discuss how the value of a star's luminosity is compared to the sun's luminosity. Students work in small groups to organize stars into different categories based on observations of properties. Students record and report their findings in a graphic organizer based on comparisons of color and size, size and luminosity and color and temperature. Teacher asks the class questions about their findings. **(IVC1b, d)** 11. Teacher overviews the **Hertzsprung-Russell diagram**, specifically examining the topic of stellar evolution to show the progression of the life of a star from nebular gases to dwarf or black hole. Teacher asks probing questions using the handouts provided, as students use the diagram information to answer (**see attached pages 6-8**). Students use the data given to complete a Hertzsprung-Russell diagram. **(IV C1c) (RST.2)** 12. Teacher presents information from "The Educator's Guide to The Inverse Square Law" at http://www.solarviews.com/eng/edu/invsquar.htm. Students use a simple mathematical relationship known as the inverse square law to explain how brightness, distance, and gravitational pull are related. **(IV C1a)**	

TRADITIONAL ASSESSMENT	TEACHER NOTES
1. Multiple-Choice **Unit Test**	

TEACHER CLASSROOM ASSESSMENT	TEACHER NOTES
1. Evaluation of oral presentations done throughout the Unit **(IV A1a, b, c; IV C1b, c)** 2. Lab/hands-on work **(IV C1b, c)** 3. Notebooks **(IV A1a, IV B1, IV C1a, b, d)** 4. Evaluation of: Why is the Sky Dark at Night? **(IV C1a)**	

AUTHENTIC ASSESSMENT	TEACHER NOTES
1. Students design a travel brochure about a manned flight to a galaxy beyond our solar system and the Milky Way Galaxy. The journey must visit at least one star beyond our galaxy. Students create a visual display of information (e.g., poster, drawing, brochure, comic book) describing the journey they designed. The information should include the following claims: • directions on how to get there (use reference points from the Celestia simulation program) • description and/or drawing of the space transport vehicle needed to complete the journey and the conditions to be encountered along the way • description of the star(s) and galaxy (i.e., size, type, composition, distances from Earth) • the stable living conditions required for human existence and how they will be maintained Claims must be supported by mathematical data/calculations (e.g., distances measured in kilometers/light years/scientific notation, time required to get there, speed of transport vehicle, power of magnification used to observe, fuel requirements). Students visually display their information, including descriptive annotations (e.g., poster drawing, a brochure) (**IVA3a,b,c) (RST.2; WHST.9)** 2. Design a lesson to be used to instruct 5-6 grade students on the topic of galaxies. Include formation, components, shape, and size. Include in the lesson visuals, discussion questions, and handouts. (**IV B2, IVB3) (RST.2; WHST.9)**	

AUTHENTIC ASSESSMENT	TEACHER NOTES
3. Students work in pairs or threesomes to prepare and deliver a one to two minute news report announcing one of the following discoveries or topics: Cepheid variables, super novae, dark matter, cosmic background radiation, black holes, and globular cluster. **(IV C1a, d) (RST.2; WHST.9)** 4. Review progress on student goals	

Name ____ Date ______
Period __________________ Lab _______

THE HERTZSPRUNG-RUSSELL DIAGRAM

Astronomers use two basis properties of stars to classify them. These two properties are luminosity and surface temperature. Luminosity usually refers to the brightness of the star relative to the brightness of our sun. Astronomers will often use a star's color to measure its temperature. Stars with low temperature produce a reddish light while stars with high temperatures shine with a brilliant blue-white light. Surface temperatures of stars range from 3000 degrees Celsius to 50,000 degrees Celsius. When these surface temperatures are plotted against luminosity, the stars fall into groups. Using data similar to what you will plot in this activity, Danish astronomer Ejnar Hertzsprung and US astronomer Henry Norris Russell independently arrived at similar results in what is now commonly referred to as the HR diagram.

Purpose: To make a Hertzsprung-Russell diagram.

Procedure:

1. Plot the stars listed in the data table at right on the graph paper provided.
2. Draw a circle around each grouping of stars on your graph.
   How many groups did you circle? ___________
3. Label the following on your graph: main sequence, red giants, white dwarfs, supergiants.
4. Circle the dot representing the sun. What type of star is the sun? ___________________

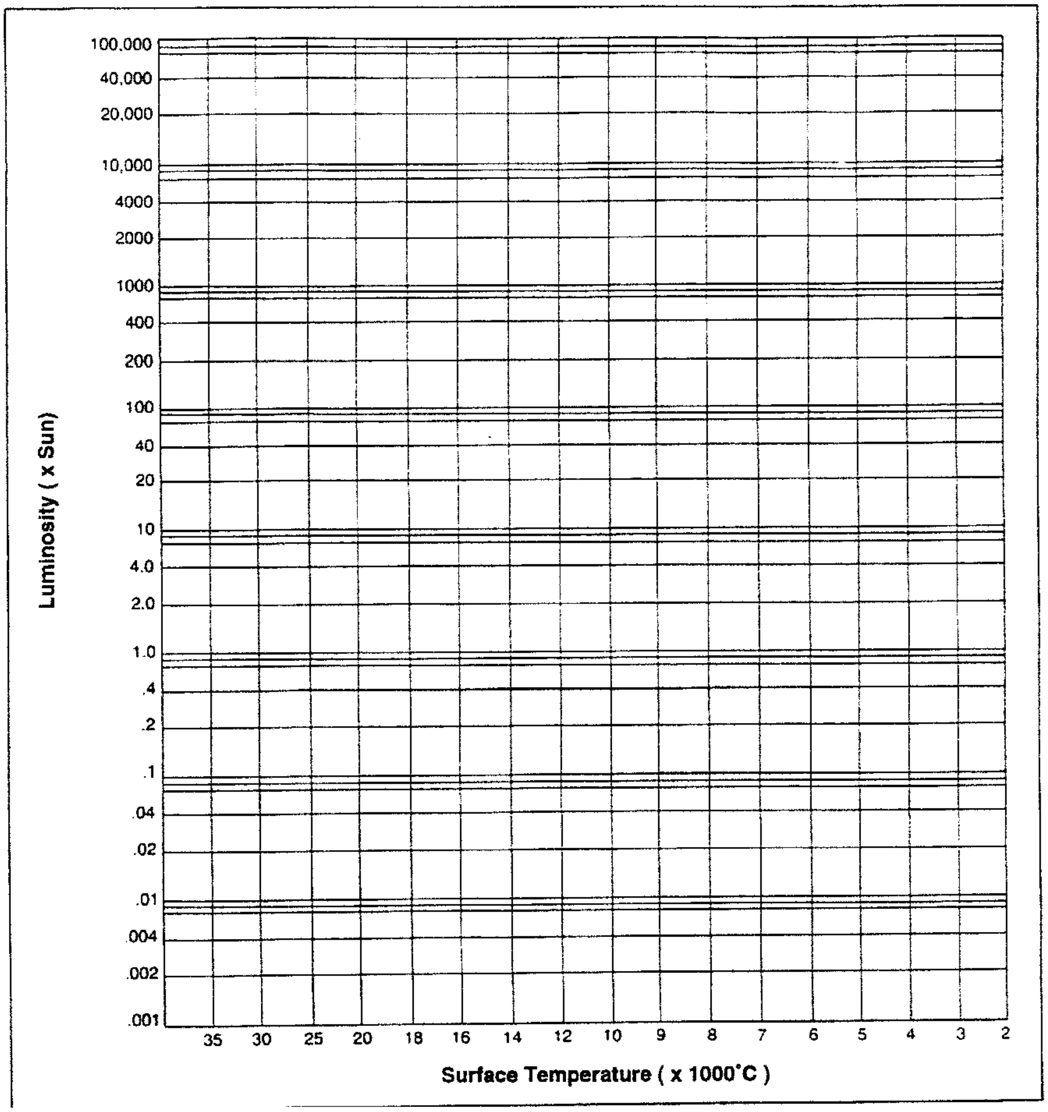
STAR	LUMINOSITY (X SUN)	SURFACE TEMPERATURE (X 1000°C)	STAR	LUMINOSITY	SURFACE TEMPERATURE (X 1000°C)
1. Orion	10,000	20	2. Betelgeuse	20,000	3
3. Polaris	6	5.9	4. Achemar	2,000	24
5. Antares	1,000	3	6. Aldebaran	100	4
7. Spica	800	25	8. Ceti	.1	4.5
9. Vega	40	12	10. Sirius A	20	11
11. Procyon A	50	6.9	12. Sun	1	5.7
13. Regulus	1,000	18	14. Procyon B	.004	6.6
15. Lacaille	.02	4.5	16. Altair	.01	9
17. Sirius B	.01	8	18. Alpha Centauri	1.6	5.7

Conclusions:

5. **How many types of stars are shown on the HR diagram?** ________________________
6. **How do the brightness and temperature of the sun compare with those of other stars?**
7. **What is the relationship between luminosity and temperature for stars on the main sequence?**
8. **Is there a relationship between mass and luminosity for stars on the main sequence?**
   __________ **If so, state the relationship.**

NAME ____

HERTZSPRUNG-RUSSELL DIAGRAM



Laboratory 7 - Hertzsprung-Russell Diagram

Materials Used: Scaling transparency, photographs of the Trapezium and Pleiades star clusters, Excel spreadsheet.

Objectives: To investigate Hertzsprung-Russell diagrams; to estimate the ages of stars from the HR diagram; to study the evolution of stars and star clusters.

Discussion: Hertzsprung-Russell (HR) diagrams are plots of stars by luminosity (intrinsic brightness) versus spectral class (color). The same distribution may be achieved by plotting luminosity or absolute magnitude versus spectral class or color index or surface temperature. HR diagrams are very useful for determining the age of a group of stars.

A HR diagram of most random groups of stars will display three groups: red giant stars, main sequence stars and white dwarf stars. Figure 1 is a depiction of a HR diagram.

The largest group of stars in any HR diagram is the main sequence. The main sequence is common to all HR diagrams and is the longest stage of evolution for any active star. A star on the main sequence derives its energy almost entirely from a nuclear reaction involving the conversion of hydrogen to helium via fusion. A star spends most of its active life on the main sequence.