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“Interstellar Space Travel and Space Technology: The Solar System and Beyond”

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The goal that I, as a science teacher, expect to accomplish with the “Interstellar Space Travel and Space Technology: The Solk System and Beyond” curriculum is to have 7th/8th grade Earth Space Science students develop an understanding of the following: composition and formation of the Universe, composition and formation of our Solar System, dating processes of the Universe, problems and accomplishments of interstellar space travel and space technology, findings of space missions, exploration of the possibility of life in space, and the construction of our space station. One emphasis in this curriculum will be on how scientists can only study our planetary system orbiting the Sun, because it is uncertain if there are any other planetary systems accompanying other stars.

The curriculum is designed to integrate the following: readings of texts and current scientific journals, writings based on students’ opinions of astronomical/cosmological issues, and cooperational activities for groups of students. The approach for this curriculum is interdisciplinary, combining science and mathematics. Teachers are urged to read Mr. Eddie Rose’s curriculum unit, which was developed in collaboration with this curriculum unit. Upon reading Mr. Rose’s mathematical unit, it will become apparent how mathematics and science play a critical role in developing answers for the questions that can be addressed in astronomy/cosmology. Some of these questions might be: What is the composition of our Universe? How was our Universe formed? When was our Universe formed? How was our Solar System formed? When was our Solar System formed? How can we calculate the origin of our Universe, and to what precision can we do this? How can we make comparisons of the planets? What are some problems with interstellar space travel? What are some accomplishments in space technology and space missions? Is there a possibility of life on other planets? What is the International Space Station? Who is building the space station, how is its being built, and why is it being built?

In order to answer the above questions, the students need to understand that the scientific method places a vital role. Therefore, one intended outcome for this curriculum is to enable students to demonstrate and interpret steps used to attain solutions/approaches for scientific problems/questions. In other words, the students will be able to apply to any situation the scientific method, for astronomy/cosmology, or any field. Students will be reinforced with the steps of the scientific method from the first day of school to the last. After students first learn what the scientific method is and why it is used, they will need to apply it to various situations and to test its success. Throughout the school year, students will be asked to conduct labs that are formatted as the scientific method: problem(s) to be solved/analyzed, hypothesis, observations, experiment, data, conclusion. By the end of the school year, each student should automatically address each situation by using the scientific method.

The student population that I will be targeting for this curriculum will be for my 7th/8th grade Earth Space Science class. These students might already have a minimal basis of astronomy/cosmology, but will need to extend their knowledge of scientific terminology and processes. At my school, the student/teacher ratio for Earth Space Science class is approximately 10:1 therefore, a considerable amount of individual attention may be given for each student. This concentrated focus on each student's comprehension and performance will allow me to expand on certain topics that are of special interest to the students. Also, each student's working pace can vary depending on the activity she is doing. This will permit some students to stay on one topic for an extended period of time, or to move ahead to another topic of particular interest.

The textbook that will accompany my curriculum is the Prentice Hall Science *Exploring the Universe* . This text contains the following chapters and subchapters: 'Stars and Galaxies', 'A Trip Through the Universe', 'Formation of the Universe', 'Characteristics of Stars', 'A Special Star: Our Sun', 'The Evolution of Stars', 'The Solar System', 'The Solar System Evolves', 'Motions of the Planets', 'A Trip Through the Solar System', 'Exploring the Solar System', ' Earth and Its Moon', 'The Earth in Space', 'The Earth's Moon', 'The Earth, the Moon, and the Sun', and 'The Space Age'. All of these chapters and subchapters emphasize what my curriculum will entail. After the students have read these sections, discussed these topics, completed activities pertaining to these topics, and explored additional relevant areas of study, they will have a substantial understanding of astronomy/cosmology.

In analyzing the composition, formation, and evolution of the Universe, several theories may be applicable, but our classes will study the theory with currently available evidence suggesting that the Universe came into existence in one singularity some 13 billion years ago. During the earliest phase of this event, the temperatures and densities were so extreme that neither space and time, nor matter and energy, nor the laws of physics were as we know them today. Students will be astounded to know that scientists are able to partially explain the steps that are believed to have marked the evolution from the initial extreme conditions to the more familiar ones of today.

The classes will learn that the earliest point in time that scientists are able to use the laws of physics to explain the formation of the Universe is at 10^{-43} second. At this time, black holes, microscopic in size and lasting for only 10^{-43} second, were continually forming and bursting, and the temperature was extremely high. At age 10^{-35} second, the temperature had fallen slightly. At age 10^{-12} second, the Universe began to expand and evolve, and it would continue to do so. Age 10^{-6} second, the Universe, still in a state of rapid expansion, contained protons, neutrons, and electrons. These three main subatomic particles were in continuous chaotic motion, colliding and reacting with each other. By age 1 second, the temperature had dropped considerably, and it continued to drop at age 5 seconds. When the age of the Universe reached 1 minute, the temperature dropped further, but it was still hot in the range of 40 to 80 times the central temperature of the Sun. During the time period of 1 -5 minutes, collisions between the particles became much less violent than they had been earlier. These collisions between protons and neutrons produced stable nuclei that were not torn apart again by further collisions. These protons and neutrons fused to form nuclei of hydrogen and helium. By the time the Universe was five minutes old, matter now consisted of roughly 76% hydrogen and 24% helium. The Universe now appeared opaque, resembling a thick fog, except that it was much hotter. It would not be until age 500,000 years that the Universe would become transparent, as it still is today. (Kutter, 1987)

Several theories have been applied to exactly how our Universe was born, but our current understanding leads us to the Big Bang Theory. This theory has grown most popular in the past several years as more and more research has been conducted to support it. The Big Bang Theory states that our Universe was formed from a singularity, as once one large concentration of matter and energy with extreme heat and pressure. The Big Bang is the point at which we believe was the “coming into being” of our universe.

The next concept that the class will need to understand is that the birth of our Universe and the birth of our Solar System were two distinct events. The birth of our Solar System happened much after the birth of our Universe. Scientists hypothesize that the formation of the Solar System was a slow, quiet process requiring dense cold clouds, in contrast to the formation of the Universe which researchers believe needed intense heat and pressure. Also, our Solar System’s birth may have been triggered by a supernova, while our Universe’s birthplace started from a singularity.

Even though several theories may vary on specifics of the formation of our Solar System, there is a consensus among astronomers that the it was born about 4.5 billion years ago. The Sun, forming in the center, attracted most of the mass and evolved into a self-sustaining star. The clump of mass remaining contained the raw materials of 73.6% Hydrogen, 24.8% Helium, and 1.6% heavier elements. Before compression, the clump was roughly 0.1 to 1.0 light years across. (Today we can think of our Solar System as 312 light minutes in diameter). (1 light year = 9,461,000,000,000 kilometers). After compression, its size was reduced by roughly a factor of ten. Most of its material was condensed into molecules and dust grains. The rest of the gas and dust collapsed into a disk, where it was heated by the proto-Sun. As gravity pulled the material together, it began to rotate faster. The orbiting dust particles were so densely packed there that they collided very frequently with each other and coalesced into growing bodies, first of pebble size and then of boulder size and larger. Quite rapidly many of the bodies reached diameters of tens to hundreds of kilometers and became the “little planets.” At first, when these little planets were still very small, they had a rather loose structure, similar to that of dust grains. However, as they grew in size, gravity compacted them into hard, solid objects. (Kutter, 1987)

From theoretical applications, we believe that the inner planets were formed from smaller pieces of nebulae, while the outer planets, excluding Pluto, were formed from larger pieces of nebulae. In the outer Solar System, solid planetary cores formed that were large enough to attract and hold part of the remaining gases of the solar nebula, thus creating their own miniature “solar nebulas,” which gave rise to their regular satellite systems. The rings may have formed in the same way, but they could equally be the product of later impact fragmentation of inner satellites. Ultimately, the remnants of the original nebula were blown away by strong solar winds from the young Sun. It is important to note that all the planets were born in orbit, and today we still see our nine planets revolving around the Sun in an elliptical orbit. Today we combine the Sun, its planets, and the stars, plus great clouds of gas and dust, as part of the enormous system called the Milky Way Galaxy, which is 100,000 light years in diameter and contains more than a hundred billion stars. (Kutter, 1987)

After learning about the formation of our Universe, students must then understand how it has evolved and how it is still evolving today. An explanation of the dating processes of our Universe is necessary. Students will soon realize that scientific notation is needed to represent the age of our Universe at certain periods of time. In collaboration with a math teacher, the science teacher can reinforce applications of scientific notation. Students will learn that not only can it be applied to extremely large numbers like distances in space, but also very large numbers such as populations of bacteria or concentrations of blood cells. By receiving instruction on how to write scientific notation and how to do computations with calculators in science and math classes, students will be further reinforced with this representation .

In discussing the dimensions and masses of atoms, planets, and satellites, as well as distances between objects in the Solar System, the students will encounter some very large and very small numbers. Instead of coping with a lot of zeros, it is easier to resort to what is called scientific (exponential) notation, or powers of 10. This way they can write one million as 10^6 instead of 1,000,000. They can think of the exponent as giving the number of zeros following the 1. Thus $10^0 = 1$. Similarly for small numbers: 1/10 is simply 10^{-1}, 1/10,000 is 10^{-4}. The negative exponent tells the number of places to the right of the decimal point. For example, the diameter of a hydrogen atom is $0.00000001 = 10^{-8}$ centimeters. Still further simplifications are used. The distance from the Earth to the Sun is 93 million miles or 93×10^6 miles or 149.6 million kilometers or 149.6×10^6 kilometers or 1.5×10^{13} centimeters.

Along with numerical values written in scientific notation, students can also learn how scientists use astronomical units (AU) to measure distances within in the solar system. (1AU = 1.4959787 x 10 11 m). Since scientists put a value of the distance from the Earth to the Sun as 1 astronomical unit, this convenient unit can often be used to give other distances in the solar system. For example, Jupiter is 5.203 astronomical units from the Sun. Another way to visualize one astronomical unit is to think of it as approximately eight light minutes. This idea can then help in determining distances by the units of meters or light years.

In addition, radioactive dating can be applied for dating items in space since it is a technique of determining the ages of rocks or other specimens by the decay of certain radioactive elements. We can use this method because radioactivity is the process by which certain kinds of atomic nuclei naturally decompose (with a specific half-life) with the spontaneous emission of subatomic particles or gamma rays. For example, when a lunar rock was collected by Apollo 17, astronauts were able to deduce the age of the Solar System. The age of this rock, as determined by comparing traces of the long-lived radioactive element Rubidium -87 (half-life = 48.8 billion years) and its decay product Strontium -87, is estimated to lie between 4.5 and 4.6 billion years. It is among the oldest known rocks of the Solar System and is believed to date back to the time of its formation. The decay of Uranium (half-life = 4.47 billion years) and Thorium (half-life = 14.0 billion years) produce the lead isotope Lead -206. Lead -206 is also a common method of dating the formation of the Earth. All of these examples of radioactive elements can be used to date items in space because of their very large half-lives. Since we know that the Universe is billions of years old, we need to use radioactive isotopes that decay in a time period of billions of years. (Morrison, 1988)

Figure A and the end of this paper is a graph that shows the decay of radioactive atoms as it compares the fractions of numbers of atoms to the half-lives. At time zero, there is a given number of radioactive atoms. The atoms decay into their offspring products at rates such that after one half-life, half the atoms remain; after two half-lives, one-quarter of the atoms remain; and so forth. (Morrison, 1988)

Another area of study for the students is to learn about the problems and accomplishments of interstellar space travel and space technology. Here, students can research various space missions such as Pioneer, Voyager, Skylab, Viking, Apollo, etc. Students can learn how the scientific method can be applied to what these missions wanted to research. As the class reviews and practices the scientific method, they can then be able to use it for different problems they are attempting to solve. Below is an example of the scientific method written for the space missions. Throughout the students' research of these missions they can try to explain:

#1 What initial problem(s) the scientists wanted to solve or learn about on the mission.
#2 What scientific observations did the scientists make on the mission.
#3 What original hypotheses did the scientists have previous to the mission.

#4 What experiments did the scientists do on the mission.
#5 What were the results/findings of the mission.
#6 What conclusions did the scientists make regarding the mission.

Below are brief descriptions of a few space missions in which students can research. Students are encouraged to research these missions or any other ones that interest them.

Pioneers 10 and 11: Launched in 1972 to study Saturn and Jupiter. Measured the increase in atmospheric density of these planets determined by the gases present and the local temperature and pressure. Studied the rings of Saturn. Obtained photographs of these planets. (Morrison, 1988)

Voyagers 1 and 2: Launched in 1979 to study Saturn and Jupiter. Measured the magnetic field, properties of charged particles in immediate environment, used remote sensing techniques to study the radio, light, and infrared radiation reflected and emitted by the planets, satellites, and rings. Discovered that Saturn has long-wavelength radiation. Obtained photographs of these planets. (Morrison, 1988)

Viking: Launched in 1976 to study Mars. Tested soil samples of Mars and found no evidence of organic compounds implying that life did not exist there. Tested atmospheric samples of Mars and found only compounds expected if life did not exist there. Obtained photographs of Mars, including the infamous "face in the dust". One interesting fact here is that Viking needed to avoid the biological contamination (accidental carrying of terrestrial microorganisms to another planet) of Mars by sterilizing the spacecraft. (Morrison, 1988)

Skylab: Launched in 1973, and stayed in orbit until 1979, to study various aspects of space. Used solar telescopes to measure radiation in the high-energy ultraviolet and x-ray regions of the spectrum. Obtained photographs of Sun's corona, sunspots, prominences, solar winds, solar eclipses and stars to deduce compositions, densities, and temperatures of these regions. Obtained information about the motion, physical state, and magnetic environment of Sun's surface. Studied the processes by which energy is transferred from Sun's interior out into space. Investigated flammability of materials in zero gravity. Studied how effectively astronauts could repair and maintain equipment. Evaluated spacesuits and mobility aids. Measured response of muscular and circulatory systems to zero gravity. Conducted pre- and post-flight measurement of calcium in bones. Collected urine samples in flight for later analysis. Used remote sensing of Earth to locate crops, minerals, and water supplies. Experimented with red blood cell metabolism, red blood cell life span, blood volume, sleep monitoring, mice circadian rhythms, melting of metals, and growth of crystals. (Compton, 1983)

Apollo 7, 8, 13, 17: Launched in 1960's to study the Moon. Obtained photographs of the Moon and Earth's land and weather features. Apollo 8 was the first manned spacecraft to orbit the Moon.

Studied the geology, seismology, origin, history, and composition of the Moon. Discovered that the Moon did not have an iron core. Used retroreflectors to determine distances from the Moon to the Earth.

Students will learn that sometimes scientists make correct hypotheses, but other times they make incorrect ones. Students will explore the exciting accomplishments of some missions. Students will also discover the advances in space technology as through the succession of the missions.

As a culminating cooperating activity of science and mathematics, the classes will study and reconstruct the building of the international Space Station currently underway. This activity will work well using an interdisciplinary approach with the combination of a science and math teacher. The students can learn about the international Space Station from the science teacher, and then they can participate in the hands-on activity of reconstructing the space station from the math teacher. Science will teach the students about scientific processes and theories, while math will teach them geometry, statistics, and budgeting.

Students will learn that this $27-billion orbiting laboratory is now taking shape at a Boeing plant in Huntsville, Alabama, at the Khrunichev works in Moscow and at other locations around the globe. The nations helping to fabricate and maintain the space station are U.S.A., Russia, Japan, Canada, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, and the United Kingdom. Combining the resources and scientific expertise of these 13 nations, the international Space Station is the largest cooperative scientific effort ever. (Scientific American, June 1996)

Figure B at the end of this paper is a representation of the international Space Station identifying each nation's major contribution to the Space Station. (NASA Educational Materials 1995)

The station's architecture consists of a Russian wing with its own laboratory module, living quarters, docking compartment and power system: the U.S. Laboratory and habitation modules: 16 solar panels and a robotic arm: and Japanese and European laboratory modules. Its entire structure, when on the ground, would cover 14 tennis courts, and will be assembled over five years and after 44 launches of U.S. space shuttles and European, Japanese, and Russian rockets. On completion, the complex will support a crew of six, who will enjoy a pressurized volume equivalent to the passenger compartments of two jumbo jets. (Scientific American, June 1996)

But why is the Space Station being built? Daniel S. Goldin, NASA's administrator, replies "The space station is being built to see how people can live and work safely and efficiently in space. We can do stunning science in fields ranging from biotechnology to materials processing." Originally, the station was to study remote sensing of Earth. Currently though, the emphasis has switched to studying the effects of weightlessness (microgravity) on humans and on physical and biological processes. Scientists hope that microgravity research will lay the foundation for important advances in medicine, food, safety, shelter, communications, transportation and environment. Daniel C. Carter, a NASA protein crystal scientist, wants to grow crystals of medically important proteins in orbit. His list includes an enzyme from the AIDS virus crystallized with a drug, a protein produced by an oncogene and a blood-clotting protein. In addition, interest focused on the observation that liquids in microgravity are strongly affected by forces such as surface tension, suggest possible advantages for separating mixtures of materials. Microgravity also seems to offer benefits for creating extremely thin coatings of polymers or semiconductors. Along with scientific advantages, supporters estimate that this program will create tens of thousands of high-technology U.S. jobs directly, and thousands more in spin-off fields. (Scientific American, June 1996)

Another activity for the classes will be to compare/contrast the pros/cons of the space station to determine what good it actually is. This activity focuses on critical thinking skills which are emphasized in the CAPT tests given to 10th grade students annually. By having the students compare, contrast, evaluate, and debate, they are using higher-order thinking which helps expand their minds. Since the CAPT test stresses higher-order thinking, students in my classes will have an added advantage to achieve a higher score.

The following is a list of pros/cons for the construction of the space station:

Pros:	Cons:
microgravity experiments	Do microgravity experiments justify \$10,000 to \$20,000 per pound for shuttle launch costs?
microgravity experiments	aircraft flying parabolic trajectories and automated spacecraft can do a lot now, for far less expense
test lower-cost heating and cooling systems	What could then happen to prices of gas, coal, and oil?
investigations that can greatly enhance the development of medicines. This can lead to possible cures, preventions, or treatments for cancer, diabetes, emphysema, parasitic infections, or immune system disorders	What if mutations or severe side effects develop?
clear view of Earth’s atmosphere is beneficial for both astronomical and environmental studies	space station is too jittery for high-precision measurements
prestige for astronauts/national recognition	risk of injury to astronauts
high-tech jobs in the aerospace industry	sufficient energy sources and supplies that need to be considered for the space station
spin-off scientific fields	pollution

Finally, there is a question that extends far beyond the existence of other planetary systems. Might there not also be other planets with life, even intelligent life, orbiting nearby stars? We do not know, but the search—SETI (searching for extraterrestrial intelligence)—has begun for radio signals from such other technical civilizations. The first serious SETI program, aimed at surveying the entire sky with a radio receiver sensitive simultaneously to 8 million different frequency bands, has begun in the mid-80’s, supported by a public-interest group called The Planetary Society. Major funding for the 8million-channel receiver was provided by Steven Spielberg, maker of the science-fiction film E.T. The next step planned for SETI was a program to be funded by NASA that would use a 10-to 100-million-channel spectrum analyzer for both an all-sky survey and a targeted search. The survey would cover the entire northern and southern sky, with a sensitivity about 300 times greater than that of any current surveys. The targeted search would examine in greater detail more than 700 nearby stars that are similar to the Sun, those considered most likely to have planets. It would also respond immediately to any hints of signals discovered by the all-sky survey. This program was estimated to require about ten years to complete. The search for signals would be about 100,000 times more extensive in its combination of sensitivity, number of targets surveyed, and frequencies covered than previous efforts. Nevertheless, the detection of extraterrestrial intelligence cannot be guaranteed. It may be that a much larger collecting area than any currently available antennas is needed for the detection of extraterrestrial signals. We will not know until we try. But scientists do strongly believe that smaller forms of life, maybe bacteria, viruses, protists, or a new type of microorganism exist somewhere beyond Earth. (Morrison, 1988)

What would the discovery of extraterrestrial signals mean? Well, it could mean opening the possibility of establishing communication with extraterrestrial intelligent creatures, which would be one of the most significant events in human history. We think that if such a place exists, and if its inhabitants are transmitting high-powered radio signals in our general direction, then it is well within the capabilities of current radio telescopes to detect these signals. The discovery of such signals would not only demonstrate the existence of other planets, but would of course tell us a great deal more.

Regarding the debate of life on other planets, the classes will read articles pertaining to this and formulate an opinion on whether they approve or disapprove of searching for extraterrestrials. Students will need to support their decision with valid information attained from the articles. Students can learn to appreciate another person's point of view, even if they disagree with others' opinions. This is an important skill in our society as not all people share the same points of view, values, or ideas.

Overall,"Interstellar Space Travel and Space Technology: The Solar System and Beyond" is a curriculum designed to promote cooperative groups, scientific thinking, problem-solving, communication skills, writing skills, computer skills, and mathematical/scientific applications in the field of astronomy/cosmology. This curriculum is designed for 7th and 8th grade Earth Space Science students, but it can be easily altered for other grades. Students will find this curriculum extremely interesting and useful as it fosters creativity, curiosity, and imagination of our universe.

science classroom activities:

Day 1

The objective is for students to understand the composition of the Universe and how the Universe and Solar System were first formed.

Students will learn that throughout history, humans have continuously struggled to try to understand the place our planet occupies in this starry realm. They will realize that our ancestors gave names to the stars and the patterns they appear to form. The teacher will ask students to list items in our Universe: some possible responses—stars, planets, moons, comets, asteroids, meteors, meteoroids, meteorites, nebulae, galaxies and black holes. The teacher will discuss with the students what the composition is of each of these objects—gases, rock, dust, ice, metals. Ask 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?

resources: *illustrations of various stars, planets, moons, comets, asteroids, meteors, meteoroids, meteorites, nebulae, galaxies and black holes.

Day 2

The objective is for students to be able to explain how the Universe was formed, how it can change, and how scientists conduct the dating of the Universe aftering viewing and discussing a video "Beginning of the Universe", obtained from Yale University Gibbs Library. This video explains in detail how scientists use scientific notation, astronautical units, and radioactive age dating to date and measure our universe. Also, it describes the events that led up to the formation of our Universe and Solar System. Students will initially be introduced to these measuring/dating techniques in science class and then they will receive additional instruction in math class.

resources *"Beginning of the Universe" video (Yale University Gibbs Library)

*television

*VCR

Day 3 and Day 4

The objective is for students to be able to apply the following terminology with different celestial objects in the Universe:

-rotation (orbiting)
-revolution
-gravity
-escape velocity
-diameter (radius)
-temperature
-atmospheric conditions (storms, hurricanes, tornadoes, precipitation, wind, acid rain)
-atmospheric composition (elements)
-land features (mountains, valleys, deserts, forests, tropics, ice, lava, volcanoes, quakes, water)
-land composition (elements, minerals)

The teacher will ask students: How are the planets shaped? What are each planet's distance from the sun? What are each planet's land features? What are each planet's atmospheric features? Students will discuss the different gravities of each planet and explain how the planet's diameter and distance from the sun affect gravity. As the students study gravity, the Law of Gravitation (stating that the force attracting two objects is proportional to the product of their masses and inversely proportional to the square of their distance from one another) will be briefly described in science class, but will be fully expanded in math class. Along with Newton's Law of Gravitation, Kepler's Laws of Motion will aid the class in determining the following: the elliptical shapes of planetary orbits, the fact that a planet moves faster along its orbit when it is close to the Sun and more slowly when it is farther away, and calculations for planet's distances from the Sun. Again, the math class can experiment with various equations demonstrating Kepler's Laws of Motion. Next, students will discuss how different atmospheric conditions, land features, atmospheric and land compositions, and extreme high and low temperatures of each planet could explain the possibility of life on that planet. Students will also learn the different escape velocities of the planets, plus different characteristics of each planet.

The class can make comparisons of all the planets by using Earth as a standard. Most students know that Earth rotates every 24 hours (allowing us to have night and day) and revolves every 365.25 days (allowing us to have four seasons). Students can describe some atmospheric conditions on Earth such as storms, hurricanes, tornadoes, precipitation, wind, acid rain, etc.; atmospheric composition of 78% nitrogen, 21% oxygen, 1% carbon dioxide and other gases; land features such as mountains, valleys, deserts, forests, tropics, ice (glaciers, polar ice caps, icebergs), lava, volcanoes, earthquakes, water (oceans, rivers, streams, lakes, ponds); and land composition of silicates, iron, and nickel. Next, the students can begin to compare the other planets to Earth.

The students will construct a table of each planet's following characteristics:

-diameter
-distance from the sun
-color
-rotation
-revolution
-escape velocity
-high and low temperatures
-atmospheric conditions
-atmospheric composition
-land features
-land composition

Figure C at the end of this paper shows a completed table of planet's characteristics. (Prentice Hall, 1993)

resources *textbook Exploring the Universe Prentice Hall

*various additional resource books on astronomy/cosmology

Day 5

The objective is for students to be able to calculate the following averages using a calculator and a spreadsheet program on a computer. The mathematic skills here are calculating averages, while the scientific skills here are in developing an understanding of various terminology used in astronomy/cosmology. Before the class actually conducts any computations, they can hypothesize an the possible answers. This allows the students to again practice the scientific method.

-diameter of 9 planets
-diameter of 4 smallest planets
-diameter of 4 largest planets
-period of rotation of 9 planets
-period of rotation of 4 smallest planets
-period of rotation of 4 largest planets
-period of revolution of 9 planets
-period of revolution of 4 smallest planets
-period of revolution of 4 largest planets
-escape velocity of 9 planets
-escape velocity of 4 smallest planets
-escape velocity of 4 largest planets
-average high temperature of 9 planets
-average high temperature of 4 smallest planets
-average high temperature of 4 largest planets
-average low temperature of 9 planets
-average low temperature of 4 smallest planets
-average low temperature of 4 largest planets

resources

* calculators
*computers
*students’ tables of planet characteristics

Day 6

The objective is for students to compare the calculated averages in order to develop possible correlations of distances from the sun and planet diameters.

The teacher will ask students to develop possible correlations of calculated averages to distances from the sun and planet diameters. Example questions: Do planets closest to the sun have a faster period of rotation? Do planets farthest from the sun have higher temperatures? Do large planets have large escape velocities? Are small planets always closest to the sun? The students here will use higher-level thinking skills to develop possible explanations to why larger (farther) or smaller (closer) planets act the way they do. Students need to hypothesize for why the correlations developed. They need to explore various solutions/answers to their initial questions. Again, all these skills will help students score sufficiently on the CAPT tests.

resources *students’ tables of planet characteristics

*students’ calculated averages

Day 7

The objective is for students to compare the atmospheric and land compositions of various planets by constructing computerized pie charts of the elements found. Here, students will gain computer skills by using spreadsheets that insert data and create a graph of the information. Mathematic applications entail students learning percentages, while scientific applications entail students learning the chemical (elemental) make-up of different atmospheres and lands.

resources *students’ tables of planet characteristics

*computers

Day 8

The objective is for students to formulate and support an opinion on the possibility of life beyond Earth after reading an article, “Looking for Life Beyond Earth” in the textbook *Exploring the Universe* Prentice Hall, describing how and why scientists are searching for extraterrestrials and also describing specifically how scientists conduct the search for extraterrestrials. Students will be required to write an essay expressing their opinion of searching for extraterrestrials. Each essay will need to contain the following:

#1 introduction paragraph explaining the article,
#2 paragraph on why scientists should search for extraterrestrials,
#3 paragraph on why scientists should not search for extraterrestrials,
#4 paragraph on their opinion of this article, What do they think?,
#5 conclusion paragraph summarizing the article.

resources *“Looking for Life Beyond Earth” article in the textbook Exploring the Universe Prentice Hall

Day 9, Day 10, Day 11
The objective is for students to be able to describe the problems and accomplishments of interstellar space travel and space technology in the past and present after researching a space flight in the past or present.

Each student will need to give a presentation describing a space flight in terms of the scientific method: What was the initial problem the scientists wanted to solve? What observations did the scientists make? What was the original hypothesis? What experiment did the scientists develop for the space flight? What data did the scientists obtain? What conclusions were drawn from the space flight? In order to give the presentation, students need to research their space flight of choice. Students may use books, videos, slides, educational materials and illustrations in class, or they may find additional information at local public or university libraries.

resources *space flight videos

*Apollo 13 video
*resource information/newspaper articles on various space flights
*illustrations of space crafts involved in space flights
*illustrations of data obtained from space flights
*television
*VCR

Day 12
The objective is for students to gain speaking and organizational skills as they give an oral presentation and written report about a particular space flight. Students will have the option of creating illustrations and/or computer visuals to include with their final presentation and report.

Day 13 and 14

The objective is for students to be able to describe the international Space Station, discuss its pros and cons, and explain some of its purposes. This objective can be attained by learning about the structure and function in science class, and also constructing a smaller scale model station in math class. Students will use the scientific method in determining why the station is being built and what it can or cannot accomplish. Students will also learn geometry, budgeting, and construction skills as they build the Space Station.

Day 15

The objective is for students to be able to describe some characteristics about planets and outer space after visiting a science museum/planetarium. A planetarium can help to demonstrate: the motion of the planets, field of rotating stars, different views of sky at different altitudes, and different views of sky during winter and summer.

resources * science museum/planetarium

Figure A—Fraction of Number of Atoms

(figure available in print form)

Figure B—International Space Station Assembly Complete

(figure available in print form)

Figure C

(figure available in print form)

Bibliography for Teachers:

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Materials for Classroom Use:

National Aeronautics and Space Administration NASA Educational Materials: illustrations, videotapes, slides, computer software. (can be ordered from Teacher Resource Laboratory: Goddard Space Flight Center, Greenbelt, MD 20771).

Video: “Beginning of the Universe” (found at Yale University Gibbs Library).

Video: “Apollo 13” (found at video stores).

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