Cherry Hill Public Schools
Planetary Exploration A Course Outline

I. General Information

A. Grade Level: 11th and 12th Grade - Accelerated Level
B. Prerequisite: Geometry
C. Credits: 6 Credit-Hours, one double lab-period per week
D. Approval: Summer 2001
E. Written by: Mark Brandreth, Scott Sweeten & Chuck Kim (Chair)

II. Purpose

A. Description

This program is a technology-rich, integrated program designed to meet the needs of students that are science and non-science majors alike. Its purposes are to help students:

(1) realize the important role that science will play in their personal and professional lives,
(2) use principles of science to think more intelligently about the universe they live in and about the current issues of science and technology, and
(3) develop a lifelong awareness of the potential and limitations of science and technology.

This program will address the following essential questions:

(1) What physical and chemical systems of earth can support life?
(2) What physical and chemical systems do the planets of our solar system have?
(3) Can other planets support life?
(4) How do the planets rotate and revolve around the sun?
(5) How does the sun produce its energy?
(6) How do the solar system and galaxies evolve?
(7) What is the origin and future of the universe?
(8) How do scientists explore the solar system and beyond?

Students will apply the fundamental concepts of earth science, astronomy, biology, chemistry, physics and technology by exploring these essential questions. In their investigation of the earth, our solar system, the Milky Way, other galaxies and the universe, they will examine real time views of various images of planets through the Internet and get connected with the various government agencies such as JPL, NASA, NOAA, etc. They may also utilize distance learning via satellite or internet video conferencing.

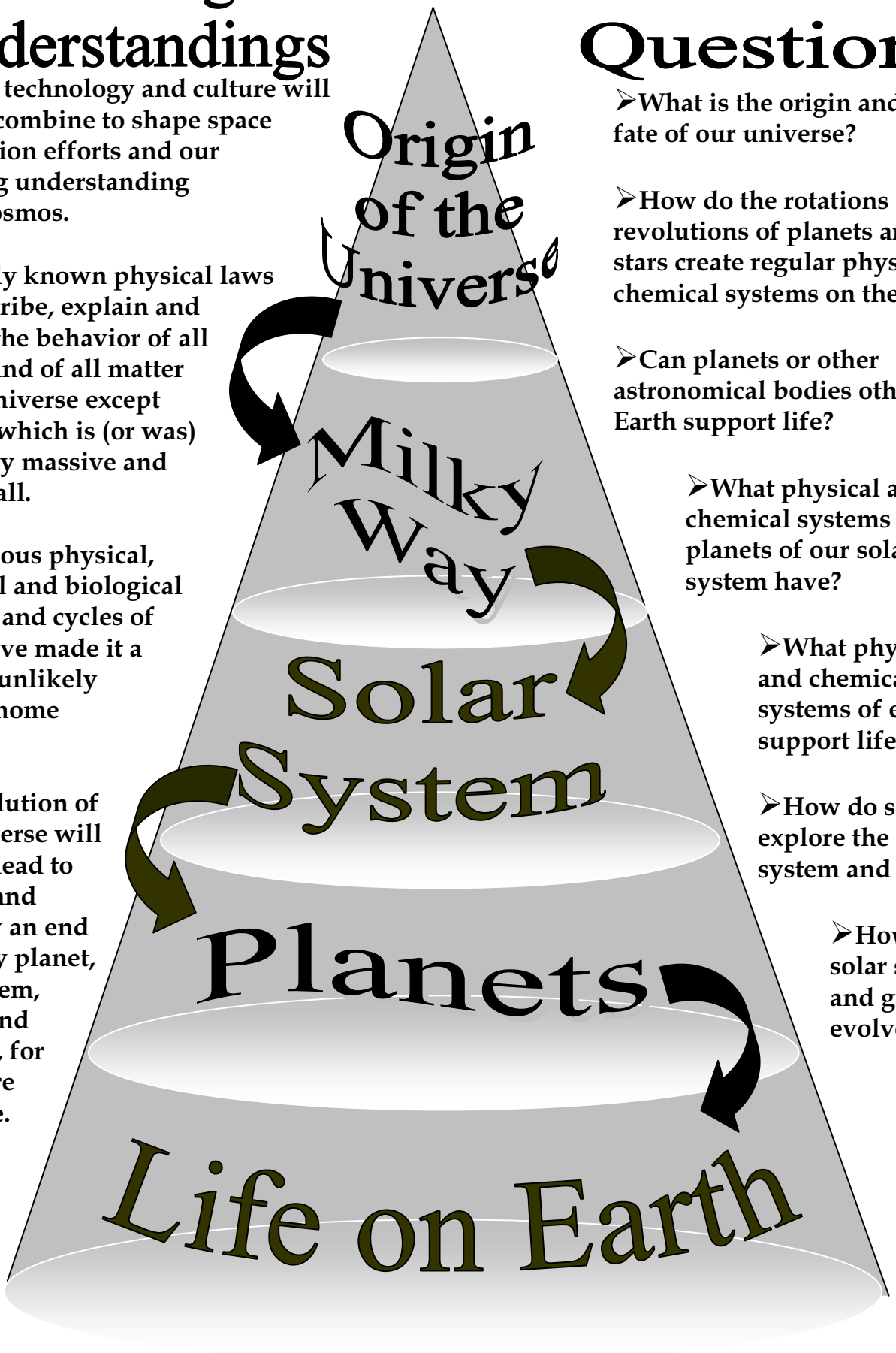
B. Course Goals[1]

1. To gain an understanding of major concepts in science.
2. To apply an understanding of mathematical reasoning and how mathematics relates to other fields of study.
3. To use computer technology as a scientific tool.
4. To learn about the earth, its relation to other objects in the universe, and the scientific principles that underlie all physical phenomena.
5. To become familiar with the scientific view of human society, social organization, and the processes of social change.
6. To become familiar with the impact technology has had on the earth and its inhabitants, and its potential for the future.
7. To acquire knowledge of the great scientific and technological revolutions that transformed human thought and action.
8. To understand the concepts of systems, models, changes, and scale as they apply in mathematics, science, technology, and everyday life.

[1]Adopted from Benchmarks For Science Literacy: Project 2061, American Association For The Advancement of Science (AAAS), (Oxford University Press, New York: Jan 1993)

Enduring Understandings

- **Science, technology and culture will forever combine to shape space exploration efforts and our resulting understanding of the cosmos.**
- **Currently known physical laws can describe, explain and predict the behavior of all energy and of all matter in the universe except for that which is (or was) both very massive and very small.**
- **The various physical, chemical and biological systems and cycles of Earth have made it a rare yet unlikely unique home for life.**
- **The evolution of the universe will forever lead to change and possibly an end for every planet, star system, galaxy and perhaps, for the entire universe.**



Essential Questions

- **What is the origin and likely fate of our universe?**
- **How do the rotations and revolutions of planets around stars create regular physical and chemical systems on them?**
- **Can planets or other astronomical bodies other than Earth support life?**
- **What physical and chemical systems do the planets of our solar system have?**
- **What physical and chemical systems of earth can support life?**
- **How do scientists explore the solar system and beyond?**
- **How do the solar system and galaxies evolve?**

III. Content Outline

A. Conditions necessary for life on Earth
    1. Geologic history
        a. Volcanism
            i. Types of volcanoes
                a. Volcanic craters, calderas
            ii. Relation to plate tectonics
                a. Ring of Fire
            iii. Extraterrestrial volcanism
                a. Mars
                b. Io
        b. Creation of atmosphere/Oceans
            i. First gases expelled from early volcanoes
            ii. Condensation of water vapor
            iii. Water Cycle
            iv. Elements brought by comets/other planetoids
                a. Comets, asteroids, meteors, etc.
    2. Chemical processes
        a. Oxygen cycle
            i. Early life on Earth
            ii. Plant life
            iii. Animal Life
            iv. Relationship between plant and animal life
        b. Organic Chemistry?
    3. Solar energy
        a. How does the sun produce energy?
            i. Nuclear Fusion
                a. Fission vs. Fusion
        b. Seasons
B. Exploration of Solar System
    1. History of
        a. Galileo
        b. Kepler
            i. Kepler's Laws
        c. Isaac Newton's Law of Universal Gravitation
    2. Formation of solar system
    3. Geology of solar system
        a. Terrestrial planets
            i. Cratering
            ii. Plate tectonics
                a. Seismic Waves
        b. Moons of outer planets
            i. Europa
            ii. Io
            iii. Triton
            iv. Titan
    4. Chemistry of solar system
        a. Gas Laws
        b. Atmospheres of planets/moons in solar system
            i. Atmosphere of Mars
            ii. Atmosphere of Venus
                a. Greenhouse effects
            iii. Atmosphere of Gas Giants

a. Storm systems
1. Hurricanes. etc.

iv. Atmosphere of moons

5. Methods used
   a. Ground based observations
      i. Telescopes and optics
         a. Reflection
            1. Mirrors
            2. Curved Mirrors
               1. Radio telescopes
               2. Satellite Dishes
         b. Refraction
            1. Snell's Law
            2. Lenses
   b. Space probes
      i. Uniform Circular Motion
         a. Escape Speed
         b. Gravitational "sling-shot"
      ii. Hubble Space Telescope
      iii. Fly-bys
      iv. Orbiting probes
         a. Radar mapping
            1. RADAR
            2. Doppler effect
         b. Spectroscopy
      v. Surface probes
         a. Types of sensors
      vi. Data transmission
         a. E-M spectrum, radio waves

C. Beyond our Solar System
   1. Milky Way and other galaxies
      a. Types of Galaxies
      b. Nearest Galaxy
   2. Life and Death of stars
      a. Life Cycle of Stars
      b. H-R Diagram
   3. Planets (and Life?) beyond our solar system
   4. Origin of the Universe

D. Possibility of life on other planets
   1. Suitability for life as we know it
      a. Life on other planets?
      b. Life on moons?
   2. Search for Extra-Terrestrial Intelligence

IV. Cherry Hill Science Standards and Benchmarks

CH 5.1

The student acquires the skills necessary to engage in scientific inquiry, analysis, deductive and inductive reasoning, information gathering and problem solving as essential and integral elements in the study of science.

Benchmarks

A. Identifies and communicates concepts that guide scientific investigations
B. Designs and conducts scientific investigations
C. Regularly uses technology and mathematics to improve investigations and communications; completes a minimum of one full investigation
D. Formulates and revises scientific explanations and models using logic and evidence
E. Recognizes, analyzes and communicates alternative explanations and models
F. Communicates and defends a scientific argument
G. Demonstrates an understanding that scientific explanations must adhere to criteria such as: logical consistency, openness to modifications, data based
H. Understands and explains how experimental results lead to further investigation
I. Uses a variety of media and technology to present the design and results of investigation

CH 5.2

The student develops an understanding of how people of various cultures have contributed to the advancement of science and technology, and how major discoveries and events have advanced science and technology.

Benchmarks

A. Uses information effectively to recognize and explain the role of the scientific community in responding to changing social and political conditions
B. Examines and communicates knowledge of the lives and contributions of important scientists and engineers who effected major breakthroughs in our understanding of the natural world
C. Demonstrates an understanding that scientists are influenced by societal, cultural, and personal beliefs and ways of viewing the world
D. Demonstrates how science is not separate from society, but a part of it
E. Demonstrates an understanding that scientists have ethical traditions

CH 5.3

The student demonstrates an ability to use all necessary scientific tools related to the study of science, and will use technology to apply knowledge of scientific principles.

Benchmarks

A. Demonstrates competency in using a variety of scientific tools as a means of conducting experiments, gathering data, analyzing results, and solving problems
B. Uses computers and other technological instruments to access scientific knowledge, compare data, cite present and past examples of the interrelationship and mutual influence of science, technology and society
C. Uses scientific tools, print and nonprint resources and technology to participate in a design project that identifies a problem, proposes and implements a solution, and evaluates the consequences of that solution

CH 5.4

The student demonstrates an ability to undertake a variety of types of scientific investigation (experiments, research, library media, data collection, design, field work), and to communicate results with a depth of understanding.

Benchmarks

B. Demonstrates that arguments generated from the results of scientific investigation may not have equal merit
C. Explains how experimental results lead to further investigation
D. Uses scientific investigation to distinguish between fact and opinion
E. Uses scientific investigation to create explanations, models, decisions and descriptions

CH 5.5

The student produces evidence that demonstrates an understanding of the structure, properties, and behavior of matter.

Benchmarks

B. Demonstrates an understanding of the structure and properties of matter, differentiating among elements, compounds and mixtures
H. Demonstrates an understanding of the relationship between heat and temperature
I. Demonstrates an understanding that chemical reactions either release or consume energy

CH 5.6

The student produces evidence that demonstrates an understanding of the natural laws as they apply to motion, forces, and energy transformation.

Benchmarks

A. Demonstrates an understanding of the effects of balanced and unbalanced forces on an object's motion
B. Explains how a moving object that is not being subjected to a net force will move in a straight line at a steady speed or remain at rest
C. Investigates and explains how the force of friction acts to retard motion
D. Describes the various forms of energy, including heat, light, sound, chemical, nuclear, mechanical, and electrical energy, and that energy can be transformed from one to another
E. Explains how heat flows through materials or across space from warmer objects to cooler ones until both objects are at the same temperature
F. Explains the mathematical relationship between the mass of an object, the unbalanced force exerted on it, and the resulting acceleration
G. Proves that whenever one object exerts a force on another, and equal amount of force is exerted back on the first object
H. Explains that gravity is a universal force of attraction between masses that depends on the masses and the distance between them
I. Explains that all energy is either kinetic or potential and that the total energy of the universe is constant
J. Demonstrates an understanding that waves have energy and can transfer energy when they interact with matter

K. Explains that matter tends to become steadily less ordered as various energy transfers occur

CH 5.8

The student produces evidence that demonstrates an understanding of the various sources of energy in the universe, and their effects on matter, with an emphasis on Earth's systems.

Benchmarks

A. Explains that earth systems have internal and external sources of energy, both of which create heat
B. Demonstrates an understanding of the sun as the major external source of energy
C. Identifies and describes the two primary sources of internal energy
D. Explains how the outward transfer of earth's internal heat drives convection circulation in the mantle that propels the plates comprising earth's surface across the face of the globe
E. Identifies and explains the effects of the heating of the earth's surface and atmosphere by the sun
F. Explains that global climate is determined by energy transfer from the sun at and near the earth's surface
G. Identifies the various influences on the transfer of energy from the sun (cloud cover, earth's rotation, etc.)
H. Demonstrates an understanding of geochemical cycles as they pertain to Earth's system
I. Explains how the movement of matter between reservoirs is driven by the Earth's internal and external sources of energy, and how these movements are often accompanied by a change in the physical and chemical properties of matter

CH 5.9

The student produces evidence that demonstrates an understanding of the origin, evolution, and structure of the universe and the Earth's place in it.

Benchmarks

A. Demonstrates an understanding of how earth at one time was very different from the planet we live on today
B. Identifies and explains methods by which geologic time can be estimated
C. Explains how interactions among the solid earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the earth system
D. Demonstrates an understanding of how the evolution of life caused dramatic changes in the composition of the earth's atmosphere, which did not originally contain oxygen
E. Examines, analyzes and depicts all relevant information relating to the origin of the universe
F. Examines, analyzes and depicts all relevant information relating to the evolution of the universe since the time of its origin
G. Demonstrates an understanding of the role of the stars in the formation of other elements

CH 5.10

The student produces evidence that demonstrates an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena.

Benchmarks

A. Demonstrates how human populations use resources in the environment in order to maintain and improve their existence
B. Demonstrates how natural resources have been and will continue to be used to maintain human

populations
C. Demonstrates an understanding that Earth does not have infinite resources; explains the dynamics of human consumption and depletion of resources
D. Examines and identifies natural systems and their role in the study of environmental resources
E. Investigates and explains the impact of natural phenomena and physical processes, such as earthquakes, forest fires, volcanoes, floods, and hurricanes, on the environment of different regions of the US and the world

CH 5.11

The student demonstrates an ability to integrate mathematics for problem-solving in science, and uses mathematics to express and/or model scientific themes.

Benchmarks

A. Uses computers, spreadsheets, graphing and database programs to assist in analytical procedures
B. Evaluates and expresses the possible effects of measurement errors on calculations
C. Uses mathematical equations to express physical relationships
D. Performs and expresses the results of mathematical operations based on the degree of precision of the input data
E. Uses mathematical models to predict physical phenomena

CH 5.13

The student produces evidence that demonstrates understanding of the structure, function, behavior, and diversity of living things.

Benchmarks

A. Identifies and describes characteristics of living things.
C. Identifies and explains the structure and function of molecules that control cellular activities

CH 5.15

The student produces evidence that demonstrates an understanding of the flow of energy in living systems.

Benchmarks

A. Explains the processes by which living things obtain and use energy necessary for life
B. Explains the transfer of energy among organisms

CH 5.16

The student produces evidence that demonstrates an understanding of the origin and evolution of life on Earth.

Benchmarks

A. Explains how DNA can be altered by natural or artificial means to produce permanent changes in a species
B. Explains that through evolution the Earth's present species developed from earlier distinctly different species

CH 5.19

The student provides evidence which demonstrates an understanding of motion and forces.

Benchmarks

B. Demonstrates the ability to analyze motion by graphical and analytical methods
C. Demonstrates an understanding of static and dynamic systems
D. Demonstrates an understanding of Newton's three laws of motion, and makes appropriate applications thereof

CH 5.20

The student provides evidence which demonstrates an understanding of conservation laws.

Benchmarks

A. Demonstrates an understanding of the types of energy and energy transformations
B. Demonstrates the applications of linear and angular momentum
D. Demonstrates an understanding of the law of conservation of mass

CH 5.21

The student provides evidence which demonstrates an understanding of the modeling of waves and oscillations.

Benchmarks

A. Demonstrates an understanding of the production and propagation of waves
B. Demonstrates an understanding of the properties of waves
D. Demonstrates an understanding of optics, both geometrical and physical

CH 5.22

The student demonstrates an understanding of the Field theory.

Benchmarks

A. Demonstrates an understanding of gravitational, electrical, and magnetic fields
B. Demonstrates an understanding of the interaction of matter with fields
C. Demonstrates an understanding of Newton's universal law of gravitation

CH 5.23

The student demonstrates an ability to use mathematics for all essential and necessary problem-solving, modeling and integration of knowledge related to Physics.

Benchmarks:

A. Applies appropriate mathematical skills to demonstrate scientific principles
B. Applies appropriate mathematical skills when performing one or more of the following functions: identifying problems, citing examples of interrelationships and mutual influences, determining solutions, evaluating consequences of solutions

CH 5.24

The student produces evidence that demonstrates an understanding of the structure, properties and behavior of matter.

Benchmarks

B. Demonstrates an understanding of the structure and properties of matter, differentiating among elements, compounds, and mixtures
C. Demonstrates literacy of nomenclature used in chemical formulas and reactions
I. Explains the phases of matter by use of the kinetic molecular theory

CH 5.25

The student produces evidence that demonstrates an understanding of the natural laws as they apply to energy transformation, and an understanding of the interrelationships between energy and matter.

Benchmarks

A. Describes the various forms of energy, including heat, light, sound, chemical, nuclear, mechanical and electrical, and explains that energy can be transformed from one form to another
B. Demonstrates quantitatively the heat flow that accompanies a chemical and physical change
C. Demonstrates quantitatively the energy and entropy relationships in chemical and physical processes

CH 5.26

The student produces evidence that demonstrates an understanding of how chemistry impacts the environment.

Benchmarks

A. Demonstrates an understanding of chemical reactions and their role in natural and human processes

B. Scientific Process Skills[1]

Students will:

1. Identify questions and concepts that guide scientific investigations.
2. Design and conduct scientific investigations.
3. Use technology and mathematics to improve investigations and communications.
4. Formulate and revise scientific explanations and models using logic and evidence.
5. Recognize and analyze alternative explanations and models.
6. Communicate and defend a scientific argument.

C. Affective Domain

Students will:

1. Develop scientific attitudes and interests and appreciate the contributions of science toward improved daily living.
2. Appreciate the aesthetic value and importance of the balance of nature between the living and the nonliving physical world.

[1] Proposed by National Research Council National Science Education Standards (National Academy Press, Washington, D. C.: 1995)

3. Develop personal values regarding the environment, the role of science and technology and mathematics.

D. Career

Students will:

1. Explore the various careers related to science, technology, and mathematics.
2. Demonstrate knowledge of the vocational opportunities available within the fields of science, technology and mathematics.

E. Affirmative Action

1. Students will identify the contributions to the sciences made by peoples of various colors, creeds, sexes, races, ethnic groups, ancestry, national origins, and social/economic positions.
2. Students will demonstrate sensitivity to different ideas, interests and beliefs of others through the development of multi-cultural attitude, responsibility and cooperation.
3. This course will be modified to meet the needs of special education students, English as a Second Language students or basic skills students as appropriate.

V. Curriculum Blocks, Central Concepts, Standards/Benchmarks and Activities

Blocks (Themes)	**Central Concepts**	**Textbook Content (Seeds, *Foundations of Astronomy)***	**CH Standards (Benchmarks)**	**Suggested Experiments/Activities**	**Total Time**
BLOCK I: Conditions necessary for life on Earth	1. Geologic history a. Volcanism b. Creation of atmosphere/Oceans 2. Chemical processes a. Oxygen cycle b. Organic Chemistry? 3. Solar energy a. How does sun produce energy? b. Seasons	**Ch. 2**: The Sky **Ch. 8**: The Sun –Our Star **Ch. 21**: Planet Earth **Ch. 23** Venus and Mars **Ch. 24**: Jupiter and Saturn **Ch. 26**: Meteorites, Asteroids and Comets	5.1(A-I) 5.2(B, E) 5.3(A-C) 5.4(B-E) 5.5(B,H,I) 5.6(A-K) 5.8(A-I) 5.9(A-D) 5.10(A-E) 5.11(A-E) 5.15(A,B) 5.16(A,B) 5.20(A) 5.21(A,B) 5.23(A,B) 5.24(B,C,I) 5.25(A,B,C) 5.26(A)	***Activity E3***– "Making a comet in the classroom" ***Activity B8*** *– "Motion of the sun"* ***Activity B10*** *– "Seasons"*	

Blocks (Themes)	**Central Concepts**	**Textbook Content (Seeds, *Foundations of Astronomy)***	**CH Standards (Benchmarks)**	**Suggested Experiments/Activities**	**Total Time**
BLOCK II: Exploration of Solar System	1. History of a. Galileo b. Kepler c. Isaac Newton's Law of Universal Gravitation 2. Formation of Solar System 3. Geology of solar system a. Terrestrial planets b. Moons of outer planets 4. Chemistry of solar system a. Gas Laws b. Atmospheres of planets/moons in solar system 5. Methods used a. Ground based observations b. Space probes	**Ch. 4**: The Origin of Modern Astronomy **Ch. 5**: Newton, Einstein and Gravity **Ch. 6**: Light and Telescopes **Ch. 7**: Starlight and Atoms **Ch. 20**: Origin of Solar System **Ch. 22**: The Moon and Mercury **Ch. 23** Venus and Mars **Ch. 24**: Jupiter and Saturn **Ch. 25**: Uranus, Neptune and Pluto	5.1(A-I) 5.2(A,C,D) 5.3(C) 5.4(B-E) 5.5(B,H,I) 5.6(A-K) 5.8(H) 5.11(A-E) 5.19(B-D) 5.20(B) 5.21(A,B,D) 5.22(A-C) 5.23(A,B) 5.24(B,C,I) 5.25(A-C)	***Activity C7*** *– "Venus topography box"* ***Activity C9*** *– "Planet Picking"* **Interactive web site**: http://www.jpl.nasa.gov/galileo/wedges/ ***Activity C16*** *– "Moons of Jupiter"* ***Activity C4*** *– "Observing a planet"* ***Activity J10*** *– "Building a parabolic reflector"* ***Activity C5*** *– "Circular Motion – 'Falling Down'"* ***Activity J7*** *– "Spectroscopes and spectroscopy"* ***Activity I1*** *– "Building a planetary probe"*	

Blocks (Themes)	**Central Concepts**	**Textbook Content (Seeds, *Foundations of Astronomy)***	**CH Standards (Benchmarks)**	**Suggested Experiments/Activities**	**Total Time**
BLOCK III: Beyond our Solar System	1. Milky Way and other galaxies a. Types of Galaxies b. Nearest Galaxy 2. Life and Death of stars a. Life Cycle of Stars b. H-R Diagram 3. Planets (and Life?) beyond our solar system 4. Origin of the Universe	**Ch. 12**: Formation of Stars **Ch. 13**: Stellar Evolution **Ch. 14**: The Deaths of Stars **Ch. 16**: The Milky Way Galaxy **Ch. 17**: Galaxies **Ch. 19**: Cosmology	5.1(A-I) 5.2(B,E) 5.3(A,B) 5.4(B-E) 5.5(B,H,I) 5.6(A-K) 5.8(B) 5.9(E,F,G) 5.11(A-E) 5.20(A,B,D) 5.21(A,B) 5.22(A-C) 5.23(A,B) 5.25(A-C)	***Activity G3*** *– "Investigating types of stars"* ***Activity H5*** *– "Expanding Universe"*	
BLOCK IV: Possibility of life on other planets	1. Suitability for life as we know it a. Life on other planets? b. Life on moons? 2. **S**earch for **E**xtra-**T**errestrial **I**ntelligence	**Ch. 27**: Life on Other Worlds	5.1(A-I) 5.2(A-E) 5.3(A-C) 5.4(B-E) 5.13(A,C) 5.15(A) 5.23(A,B)	***Activity I5*** *– "Message from Space"*	

VI. Teaching/Learning Strategies

Student Activities: Rather than relying on teacher lecture, the instructional strategy relies on active student learning. The typical student learning activities are composed of:

1. **Presentation of Concepts**: Students develop in cooperative learning groups their presentation of selected concepts in each block, and make their presentations.
2. **Laboratory Work**: Students collect data in a laboratory room and process their data in teams of two.
3. **Review and Test:** All review questions and exercise problems are given to students as homework.
4. **Differentiated Mastery of Concepts:** Students who fail are given an extra review of concepts and the second chance to take the test so that all students can master the central concepts and succeed in their study of science.

Average grade is recommended to be calculated using a total points method:

- Tests: generally 100 pts.
- Quizzes: generally 10-30 pts.
- Project and Lab reports: generally 20-40 pts
- Homework, cooperative learning: generally 5-20 pts.

VII. Instructional Materials

Textbooks:
Seeds, Michael A. *Foundations of Astronomy*. Brooks/Cole, Pacific Grove, CA, 2001

Basic Equipment:

- Computers with Internet connections
- LCD Projection Systems
- Digital Cameras
- Digital Camcorders
- PASCO Data Acquisition Systems and probes

VIII. Student Evaluation

Student evaluation will employ the following ***P***re-test, ***P***ost-test, ***P***ortfolio, and ***P***erformance (4-P):

A. Pre-tests: Assessment of students' knowledge prior to entry into program.
B. Post-tests: Assessment of Benchmarks (Literacy Goals) after completion of each Curriculum Block
C. Portfolio: Students' laboratory reports and cooperative research projects
D. Performance: Students' performance in laboratory and cooperative team work.

IX. Program Evaluation

A. Administer questionnaires to parents and students.
B. Evaluate:
    1. Grades
    2. Mid-term and final exam results
    3. Unit tests
    4. Problem-solving skills
    5. Data-processing and mathematical-modeling assessment
C. Monitor in future years each student's:
    1. Motivation to take higher level classes.
    2. Success in other science and mathematics courses.