Astronomy: Gravity, Stars and Galaxies

Grade Level: Sixth Grade
Presented by: Claire Overlee, South Shore Charter School, Hull, Massachusetts
Length of Unit: 15-17 days (12 lessons)

1.

I. ABSTRACT

Within this unit, students will learn about the theories of origin of the universe, the ideas held by the earliest of astronomers, planetary motion, and stars and constellations. The unit also includes
3. effects of space travel on humans, and the future of space travel.

II. OVERVIEW

A. Concept Objectives
   4. the universe.
   2. Students will be able to name and define different types of natural objects in space.
   3. ts.
   5. ge of the life cycle of a star.
   8. tellation and writing a story about its formation.
   7. Students will understand that different shapes effect rocket flight.
   8. Students will develop a time line of modern space exploration.
   9. Students will learn about the effects of micro-gravity on people in space, and conduct experiments that show these effects.
   10. Students will learn about food preservation methods utilized for prolonged space travel.
   11. Students will understand the high level of technology necessary to design a suitable equipment for humans to endure the dangerous environment of space.
   12. Students will understand the basic components included in existing space stations, and will cooperatively design and build their own space stations.

B. Core Knowledge Content
   1. Theory of origin of the universe
   2. The Solar System: The Sun and Planets
   3. Planetary Motion: Tides and Eclipses
   4. Stars and Constellations: life cycle and names of famous constellation
   5. Space Exploration: History and the Future
   6. Famous People in Space Exploration

C. Skills Taught
   1. Observation and experimentation
   2. Creative and descriptive writing
   3. Research, collect, and organize data
   4. Determine cause and effect relationships
   5. Follow directions
   6. Construct and fly a model rocket
   7. Design and construct a space station
   8. Construct a film canister constellation
   9. Identify key facts, people, and events in our exploration of space

III. BACKGROUND KNOWLEDGE

A. For teachers: See Resource List below and Bibliography
B. For students: Prior studies of the Solar System

IV. RESOURCES

Our Solar System Activity Book by Linda Milliken
Space Exploration by Jane Pofahl
Space by Mary Kay Carson
What Your Sixth Grader Needs to Know by E.D. Hirsch
Solar System Activity Book by Linda Milliken
The Solar System by Edward P. Ortleb
Our Solar System by Joan G. Springle-Adair and Kathy Zahn
Our Solar System by Rebecca Stark

V. LESSONS

Lesson One: Introduction to Unit: (one day)

A. *Daily Objectives*:
   1. Concept Objectives:
      a. Students will write down their own understanding of astronomy and what this topic encompasses.
      b. Students will share their ideas about what astronomy is, and generate a list of ideas known and questions to be answered within this course of study.
   2. Lesson Content:
      a. Assessment of students prior knowledge about space
      b. Brainstorming techniques about knowledge of space
      c. Generation of lists concerning knowledge and questions about space
   3. Skill Objectives:
      a. The students will utilize a "Type 1" John Collins method of writing to complete 6 lines about the topic of astronomy and space.
      b. The students will share their writing with the group
      c. The students will brainstorm a list of questions to be answered throughout their course of study

B. Materials:
   1. Writing paper for each student
   2. Pencil or pen
   3. Large chart paper or white board
   4. Markers and/or dry erase marker

C. Key Vocabulary
   1. Generated by students through discussion of prior knowledge

D. Procedures/Activities
   1. Tell students that they are about to begin a study of astronomy/space.
   2. Give each student a piece of "Type I" Collins writing paper, or a piece of lined paper, and make sure each student has a pen or pencil.
   3. Give students 5 minutes to write all that they know about astronomy/space.
   4. Ask students to share their ideas with the class, and record new ideas on the chart or white board under the headings of : "Known Ideas" and "Questions to Answer"
   5. Generate a list by brainstorming ideas on the topic.
   6. Post generated lists in room for future use.

E. Assessment/Evaluation
   1. Teacher will record each student as to completion of "Type I" writing.
   2. Teacher will assess class participation in sharing of ideas and brainstorming process.

Lesson Two: "Big Bang" and "Big Crunch" and other Theories (one day)

A. *Daily Objectives:*

1. Concept Objectives:

a. Students will understand the different theories of the origin and future of the universe.

b. Students will begin to understand the time frame of measuring astronomical milestones.

2. Lesson Content

a. Theories of the origin of the universe.

b. Theories of the future of the universe.

c. Time frames utilized in measurement of major events of the universe.

3. Skill Objectives

a. Students will observe demonstration of the "Big Bang" theory.

b. Students will relate the experiments to the origin and future of the universe.

c. Students will observe and then demonstrate idea of the "Big Crunch" theory.

d. Students within small groups, will read about, illustrate, and then present the theories about the origin and future of the universe.

e. The students will demonstrate acquired knowledge about these theories.

B. *Materials*

1. Hot air popcorn popper
2. Popcorn
3. Sheet or other type of large floor covering
4. Balloons
5. Markers
6. Handouts- pages 8 and 9 from *Space Exploration* by Jane Pofahl- These two pages discuss the Big Bang Theory, the Big Crunch, the Big Bore, and the Plateau Theories.
7. Large poster sized paper

C. *Key Vocabulary*

1. universe-all matter and energy considered as a whole; the cosmos
2. theory- a statement design to explain an event or a group of events
3. galaxies- a vast group of stars, gas and dust held together by the force of gravity
4. Milky Way- The edge of our galaxy as appears from the Earth
5. Big Bang Theory- The huge explosion that scientists believe started the universe moving outward
6. Big Crunch Theory- A theory that says that the universe will stop expanding outward, reverse direction, and pull back on itself to the single point
7. Big Bore Theory- A theory that says that the universe will keep on expanding forever
8. Plateau Theory- A theory that says that eventually the universe will slow down and stop expanding

D. *Procedures/Activities*

1. Spread large sheet out on floor.
2. Place popcorn popper in middle of sheet.
3. Have students sit around perimeter of sheet.
4. Place popcorn kernels in popper, and note size and shape of kernels.
5. Leaving lid off, turn on the popper, keeping a safe distance.
6. Note sounds and changes observed in the kernels.
7. When popping is complete, observe the position of the kernels
8. Relate the results of the experiment to the Big Bang theory.

9. Read and discuss the handout on the Big Bang theory.
10. Eat the popcorn(if desired)
11. Demonstrate the idea of the Big Bang/Big Crunch theories by blowing up a balloon and using a marking pen to draw small "stars" or dots on the balloon.
12. Blow up the balloon slightly.
13. Observe the relationship of the dots.
14. Continue to blow up the balloon a little at a time. Observe and draw scientific conclusions that relate tot the universe today.
15. Discuss what will eventually happen to the balloon-tow thoughts, explode or reverse and move inward.
16. Divide class into four groups. Each group will be asked illustrate and discuss one of the four theories: Big Bang, Big Crunch, Plateau or Big Bore; give out handouts and large paper and markers.
17. Allow time for each group to share their illustrations and reports.

E. *Assessment/Evaluation*
1. Teacher will evaluate individuals on their small group cooperation and participation.
2. Teacher will record each student's knowledge of the different theories discussed.

Lesson Three: Early Astronomers: Beliefs and Views (one day)

A. *Daily Objectives*
1. Concept Objectives
a. Students will understand that Ptolemy was a famous early astronomer.
b. Students will understand Ptolemy's geocentric theory of the universe.
c. Students will recognize Copernicus as a famous early astronomer.
d. Students will understand Copernicus' theory of a heliocentric universe.
2. Lesson Content
a. Early astronomers and their views of the universe.
3. Skill Objectives
a. The student will be able to place Ptolemy on a time line.
b. The student will be able to describe the geocentric theory of the universe as believed by Ptolemy.
c. The student will be able to place Copernicus on a time line.
d. The student will be able to describe the heliocentric theory of the universe a proposed by Copernicus.
e. The students will be able to write about each theory.
f. The student will be able to illustrate each theory.

B. *Materials*
1. Handout from *Our Solar System*, by Stark, page 8 (or a sheet which briefly describes the lives of both Ptolemy and Copernicus, and the beliefs of the universe (Appendix A).
2. Handout from *Our Solar System*, by Sprigle-Adair and Zahn, page 23 (or Appendix A).
3. Drawing paper for each student
4. Markers or crayons

C. *Key Vocabulary*
1. Ptolemy- Greek astronomer who produced a detailed description of the celestial bodies around the earth
2. Copernicus- Polish astronomer who developed the theory that the sun was the center of the universe
3. Heliocentric- sun-centered
4. Geocentric- earth-centered

D. *Procedure/Activities*
   1. Give out handouts about each early astronomer.
   2. Read and discuss handouts.
   3. Place each astronomer on a timeline, which is drawn on the white board or chart tablet. (add whatever other pertinent dates desired on the timeline to develop idea of relevance to other important historical dates previously studied, ie: Greece, Rome, Middle Ages, etc.)
   4. Pass out copy of Appendix A to each student.
   5. Give each student a piece of drawing paper and sufficient markers and/or crayons to illustrate two theories of the universe.

E. Assessment/Evaluation
   1. Teacher will read descriptions of the two different astronomer's theories, and grade student's work.
   2. Teacher will grade illustrations for student's understanding of heliocentric and geocentric views of the universe.

Lesson Four: Eclipses (one to two days)

A. *Daily Objectives:*
   1. Concept Objectives:
      a. Students will demonstrate their understanding of both solar and lunar eclipses.
      b. Students will illustrate a solar and lunar eclipse.
   2. Lesson Content:
      a. What is an eclipse
      b. What is a solar eclipse
      c. What is a lunar eclipse
   3. Skill Objectives
      a. Students will demonstrate a solar and lunar eclipse.
      b. Students will illustrate a solar and lunar eclipse.

B. *Materials*
   1. Four large spotlights or flashlights
   2. Large butcher paper
   3. Small rubber ball or tennis ball
   4. Large rubber ball or basketball
   5. Yarn
   6. Scissors
   7. Large paper clip
   8. Drawing paper
   9. Colored pencils, crayons, or felt markers

C. *Key Vocabulary*
   1. Shadow- the rough image cast by an object blocking rays of light
   2. Solar Eclipse- when the moon covers the sun and cast a shadow on the earth
   3. Lunar Eclipse- when the earth comes directly in-between the sun and the moon and make a shadow on the moon.
   4. Umbra- middle, and darkest part of the shadow cast by the Earth in a lunar eclipse of the shadow in witch the solar disk can be seen.
   5. Penumbra- the outside of the shadow

D. *Procedures/Activities*
   1. Handout page 5b from *The Solar System* by Milliken to each student.
   2. Use three students and flashlight, two balls of two sizes to demonstrate a solar eclipse.
   3. Discuss the position of the major objects: the Moon- (small ball), the Earth-(large ball), and the Sun-(flashlight) during a solar eclipse.

4. Look at handout and verify positions of three major parts of a solar eclipse.
5. Use three different students and flashlight and balls to demonstrate a lunar eclipse.
6. Verify positioning by looking at handout.
7. Complete questions on handout together, introducing new vocabulary: umbra and penumbra.
8. Divide class into four groups.
9. Assign groups to make a demonstration of a solar and lunar eclipse by using the large spotlight and large paper by:
    a. Cut two circles, one 6"in diameter (Moon), the other 36" in diameter (Earth).
    b. Tie a paper clip to the end of a 4-foot length of yarn.
    c. Hang the yarn from the ceiling.
    d. Set the spotlight up in the room away from the yarn, but so it is directly opposite the paper clip.
    e. Clip the earth to the yarn.
    f. Tape the Moon to the wall directly behind the Earth.
    g. Observe the results.
    h. Reverse the positions of the Earth and Moon.
10. Have each group take turns demonstrating to you their solar and lunar eclipse.
11. Give each student a piece of drawing paper and colored pencils or markers or crayons.
12. Have students draw and label a picture of a solar and lunar eclipse.

E. *Assessment/Evaluation*
    1. Teacher will evaluate each group's demonstrate of the solar and lunar eclipse for correct positioning.
    2. Teacher will note cooperation and participation of each student within the group process.
    3. Teacher will collect and check each illustration for accuracy and neatness.

Lesson Five: Planetary Fun: Scale Model of Solar System and Syllogisms (two days)

A. *Daily Objectives:*
    1. Concept Objectives:
        a. Students will comprehend the scale of sizes and distances in the Solar System.
        b. Students can determine the planets' relative distance from the Sun using a different scale.
        c. Students will display group cooperation by completing planetary syllogism challenges and inventing their own for others to try.
    2. Lesson Content:
        a. Relative sizes of planets and Sun and distances in the Solar System.
        b. Deductive arguments within the context of our study of the Solar System.
    3. Skill Objectives:
        a. The students will demonstrate comprehension of relative size of planets and the Sun by creating a scale model of the Solar System using patterns and predetermined scale.
        b. Students will use math to create another scale for this activity.
        c. Students will learn to use deductive arguments to solve syllogisms.

B. *Materials:*
    1. Appendix B – Scale of Distances and Planet Patterns
    2. Various sizes of paper
    3. Pencils
    4. Markers
    5. Scissors
    6. String or cord
    7. Fish line or thread

8. Paper clips
9. Yardstick
10. Tape measure
11. Rulers
12. Tape

C. *Key Vocabulary* :
1. Scale - a system of ordered marks placed at fixed distances used for measuring

D. *Procedures/Activities:*
1. Divide class into groups of 10.
2. Give out planet pattern sheet.
3. Have students decide on what planet they will make and place on the distance chart (or assign a planet to each member of the group).
4. Give out paper, scissors, markers, cord and tape and paper clips.
5. Have students cut out and label each planet (smaller ones will have to make a separate sign to hang above planet)
6. Attach each planet to a piece of thread or fish line at least three feet long.
7. Measure out larger cord to the distance needed on scale chart.
8. Have each student measure and place the paper planet in the correct place on the cord
9. Make sure all the distances and planets are labeled.
10. Review each model.
11. Have students choose another scale for this activity. For example, halve or double each number or set up ratios to change the scale.
12. Pass out the "Planetary Syllogisms" worksheet (Appendix C)
13. Explain what a syllogism is, and do problem #1 together.
14. Have students work in pairs to complete this exercise.
15. Review and discuss worksheets after completion.

E. *Assessment/Evaluation*:
1. Teacher will assess cooperation displayed by individual members of each group.
2. `Teacher will evaluate each group's product to assess completeness and correctness.
3. Teacher will grade worksheets for completion and originality.

Lesson Six: Gravity Stations – Effects on Tides and Objects in Space (one day)

A. *Daily Objectives:*
1. Concept Objective
   a. Students will understand the basic facts of gravity.
   b. Students will demonstrate their ability to apply these laws to the understanding of tides on Earth and the study of space.
2. Lesson Content:
   a. Basic laws of gravity.
3. Skill Objectives:
   a. The students will work at different stations to demonstrate the different facts about gravity.
   b. The students will be able to draw conclusions from their observations of activities at these stations.
   c. The students will translate the pull of gravity to the existence of tides on Earth.

B. *Materials:*
1. Handouts: Appendix D – Gravity Sheets
2. Metal tray
3. Ball Bearing
4. Marbles
5. Sugar cube

6. Die
7. Sponge ball
8. Tennis or lacrosse ball
9. Tray with a layer of clay on it
10. Rulers-3
11. Two quarters
12. Observation Sheets
13. Information on gravity from various resources

C. *Key Vocabulary:*
1. Gravity- the force of the attraction between two large objects.
2. Isaac Newton- English mathematician and scientist who formulated the theory of universal gravitation.

D. *Procedures/Activities:*
1. Prior to lesson, set up the 3 stations according to Appendix D
2. Divide class into 4 groups.
3. Explain that there are 3 stations set up.
4. The students are assigned to each station, and to complete the activity at each station before moving on to another station.
5. The 4th group is assigned to the teacher to read information and discuss the sheet on tides from reference materials.
6. Regroup class to discuss their observations and conclusions.
7. Check each conclusion with the Gravity Facts Sheet. Discuss material and the effects of gravity on objects on Earth and in Space.

E. *Assessment/Evaluation:*
1. Teacher will collect and grade worksheets.
2. Teacher will observe and assess student participation and cooperation during the activity session.

Lesson Seven: Stars: Life Cycle, Constellations and Hands on Fun (2-3 days)

A. *Daily Objectives:*
1. Concept Objectives:
   a. Students will show understanding of the life cycle of a star.
   b. Students will be able to name and understand the concept of constellations.
   c. Students will duplicate the constellation pattern for several different constellations using various mediums.
   d. Students will create their own constellation, and develop a written account for the creation of their constellation.
   e. Students will understand that legends and folklore created the constellations in the minds of ancient peoples, and that constellations are not real.
2. Lesson Content:
   a. Life cycle of stars
   b. Major constellations – configuration and names
3. Skill Objectives:
   a. The students will be able to illustrate and label the life cycle of a star.
   b. The students will be able to explain the relative brightness of stars.
   c. The student will be able to replicate several constellation patterns.
   d. The student will create his/her own constellation.
   e. The student will write a story about the formation of their constellation.

B. *Materials:*
1. Overhead projector
2. Transparency of page 10 from *The Solar System* by Milliken

3. Worksheet pages 10a and 10b from *The Solar System* by Milliken
4. *High Interest Learning: Space Exploration* by Jane Pofahl, page 20
5. Copy of A Native American Folktale - " How the Stars Came to Be", pages 27-28, *Space*, by Mary Kay Carson
6. Scissors
7. Empty film 35mm film canisters –1 for each student
8. Clear tape
9. Piece of thick cardboard
10. Thick sewing needle
11. Hammer
12. 1 and ½ inch nail
13. Black construction paper (2 pieces per student)
14. Straight pins
15. Stapler
16. Star stickers
17. White drawing paper
18. Colored pencils or felt markers
19. Worksheet of constellation patterns
20. Glitter pens or white chalk
21. Create your own Constellation Worksheet – Appendix E
22. Appendix F
23. Appendix G

C. *Key Vocabulary*:
1. Constellation- a group of stars grouped together to form a picture
2. Young Star- energy from nuclear fusion that is equal to the force of gravity.
3. Red Giant- an unstable force causes the star to expand
4. Supernova- an exploding star
5. White Dwarf- small, dense stars resulting from the collapse of a Red Giant
6. Black Dwarf- loses energy and becomes a cold, black object in space
7. Neutron Star (Pulsars)-Very dense objects made up of neutrons
8. Light Year- The distance that light can travel in a year (5,865,696,000,000 miles)

D. *Procedures/Activities:*
1. Read orally, page 20, *High Interest Learning: Space Exploration* by Jane Pofahl.,
2. Show transparency page 10 from *The Solar System* by Milliken
3. Read and discuss page 10a from *The Solar System* by Milliken on the brightness of stars and the three factors upon which it depends.
4. Complete page10b from *The Solar System* by Milliken together with students.
5. Pass out drawing paper and pencils and/or markers.
6. Have students recreate life cycle of a star using paper and markers.
7. Discuss creation of constellations, and read together the Native American folktale, "How Stars
8. Came to Be" – assign different characters within the story to different students.
9. Have students create his/her own constellation, and write a myth about how the constellation got its name.
10. Set up three areas for constellation work.
11. Area 1: Film canister constellations – Go through directions and make an example of this project with the class. Have all materials and directions available in this area.
12. Area 2: Mini-maps – Go through the beginning of this project, and demonstrate for the students. Have all the materials available in this area.
13. Area 3: Star-Struck Pictures – Go through the directions and have all necessary materials and directions available in this area for the students.

14. Collect materials and clean up all three areas.
15. Share student's work with class.

E. *Assessment/Evaluation:*
1. Teacher will evaluate the student's illustration of the life cycle of a star.
2. Teacher assessment of the student's film canister constellation.
3. Teacher will grade the student's constellation star-struck sheet.
4. The teacher will evaluate the student's mini-map of the major constellations.
5. The teacher will evaluate and grade the student's drawing and story about his/her own constellation.

Lesson Eight: Astronomy Task Force (one day)

A. *Daily Objectives*
1. Concept Objectives:
   a. Students will be able to simulate the role of an astronomer.
   b. Students will work cooperatively in a group
   c. Students will understand the role of a stellar astronomer, a planetary astronomer, and a solar astronomer.
   d. Students will create a news conference about a discovery in the solar system.
2. Lesson Content:
   a. Role of the stellar astronomer.
   b. Role of the planetary astronomer.
   c. Role of the solar astronomer.
   d. Knowledge of astronomical theories, ideas, and material previously learned about these topics.
3. Skill Objectives:
   a. The students will assume the role of a stellar astronomer.
   b. The students will assume he role of a planetary astronomer.
   c. The student will assume the role of a solar astronomer.
   d. The student will share his/her findings in a news broadcast format with the other students.

B. *Materials:*
1. Astronomer Discovery Cards from *Hands On Science, Solar System*, page 43-or
2. Appendix H
3. Paper for notes

C. *Key Vocabulary*:
1. Stellar- somehow relating to the stars
2. Planetary- of or resembling a planet or the characteristics of a planet
3. Solar- of or relating to the sun
4. Astronomer- someone who studies the stars and planets and other objects in space

D. *Procedures/Activities:*
1. Divide class into three groups.
2. Give copies of same Astronomer Discovery Cards to each group.
3. Explain that each group is responsible for coming up with a "newscast flash" to be presented to the entire class. Give adequate time for preparation.
4. Instruct students within each group to choose a discovery.
5. Have the students work together to write a script about their discovery, and assign roles.
6. Suggest that students may use small props for their presentation.
7. Monitor progress of the groups.
8. Call class together, and ask for group to volunteer to present their "newscast".
9. Remaining members of the class act as audience.

E. *Assessment/Evaluation*:
   1. Teacher will grade each group on content and presentation techniques.
   2. Teacher will assess each student for group participation and cooperation.

Lesson Nine: Space Travel Time Line (one day)

A. *Daily Objectives:*
   1. Concept Objectives:
      a. Student will understand the effect of the Earth's gravitational pull upon objects trying to escape the atmosphere.
      b. The student will understand Newton's third law of motion.
      c. The student will understand the need to use rockets for space ravel.
      d. The student will develop a timeline of space milestones.
   2. Lesson Content:
      a. The effect of gravitational pull of the Earth on escaping the Earth's atmosphere.
      b. Newton's third law of gravity: for every action there is an equal and opposite reaction.
      c. Rocket power is necessary to propel objects into space.
      d. Many important events have occurred since the beginning of space exploration.
   3. Skill Objectives:
      a. Students will verbalize the effects of gravity upon space flight.
      b. Students will demonstrate Newton's third law of gravity.
      c. Students will work together to make a timeline of space milestones.

B. *Materials*:
   1. Copies of pages 30 – 33 from *Space* by Mary Kay Carson
   2. A balloon for each student
   3. Index cards
   4. Felt markers
   5. Tape

C. *Key Vocabulary:*
   1. Gravity- the force of the attraction between two large objects.
   2. Motion- the process of moving ; change of position
   3. Thrust- the pushing force generated by a rocket's engine
   4. Satellite- an object orbiting a larger one
   5. NASA- The National Aeronautics and Space Administration

D. *Procedures:*
   1. Read and discuss first paragraph on page 30 in *Space* by Mary Kay Carson.
   2. Hand out balloons, and demonstrate Newton's third law of gravity – for every action (the escaping air) there is an equal and opposite reaction (the balloon moving forward).
   3. Continue to read and discuss pages 30 and 31 in *Space* by Mary Kay Carson.
   4. Hand out pages 32-33 , and assign a date and an event to each student.
   5. Hand out index cards- two for each student.
   6. Hand out markers.
   7. Instruct students to write the date given on one card, and the event that occurred on that date on the other card.
   8. When all have completed, have students line up according to date from earliest to latest.
   9. Attach date card and event card in appropriate spaces on the wall to simulate a timeline of space milestones.

E. *Assessment/Evaluation:*
   1. Teacher will grade student on the legibility and neatness of their cards on the timeline.

Lesson Ten: Rocket Design Contest (one to two days)

A. *Daily Objectives:*
   1. Concept Objectives:
      a. Students will understand directions for building a simple rocket.
      b. Students will recognize that fins help to stabilize rocket flight.
   2. Lesson Content:
      a. The stabilizing effect of rocket fins.
      b. Newton's third law of gravity.
      c. Following directions for construction of similar objects.
   3. Skill Objectives:
      a. The student will be able to follow the directions to build a simple straw powered rocket.
      b. Students will be able to design unique parts to enhance the flight of their rocket.
      c. Students will discover the stabilizing effect of rocket fins.

B. *Materials*:
   1. Paper cut into 1 inch strips
   2. Clear tape
   3. Construction paper
   4. Straws
   5. Fat pencils or pens (a bit fatter than the straws)
   6. Scissors
   7. Measuring strip or tape

C. *Key Vocabulary*:
   1. Fins

D. *Procedures/Activities*:
   1. Hand out copy of page 41 from *Space*, by Mary Kay Carson.
   2. Give each student a pen or pencil, strips of paper, straw, tape, scissors, and the pattern for fins (on page 41).
   3. Help students to construct two rockets; one with fins, one without fins.
   4. Hand out record sheet to each student.
   5. Tape off starting point for launching pad, and place a measuring tape along the edge of the launch sight.
   6. Students should launch and record their rocket flights.
   7. Students are given "Rocket Design Contest" sheet – Appendix I
   8. Students design unique rocket, and enter it into the contest.
   9. Class observes the contest entries, and develops categories for prizes and determines winners.

E. *Assessments/Evaluation*:
   1. Teacher will evaluate each student for successful, completed rocket construction.

Lesson Eleven: Surviving in Space (one to two days)

A. *Daily Objectives*:
   1. Concept Objectives:
      a. Students will understand that space is not a natural environment for humans.
      b. Students will become familiar with the effects of space travel upon humans.
      c. Students will appreciate problems technicians must overcome in order to enable humans to spend extended time in space.
   2. Lesson Content:
      a. The unnatural environment of space for humans.
      b. The effect of micro-gravity on humans.
      c. The methods of preserving food for extended space travel.

d. The use of simulated situations using space-type equipment.

3. Skill Objectives:
   a. The student will demonstrate his/her knowledge of the effects of space travel upon humans by making observations and drawing conclusions in several experiments.
   b. Students will complete questions describing the use of special suits to work in space.

B. *Materials*:
1. *Space,* by Mary Kay Carson, pages 44-46, or any other resource that describes surviving in space.
2. Two similar cleaned chicken bones
3. Jar with lid
4. White vinegar
5. Fruits and vegetables
6. Knives
7. Scrap paper
8. Pencil
9. Microwave or oven for drying food
10. Self-lock sandwich bags
11. Aluminum foil
12. Fresh-fruit preservative like Stay Fresh
13. Wax paper
14. One copy of Appendix J
15. Adult-size work glove
16. Cotton balls, or facial tissues
17. Needle and thread
18. Toothpicks
19. Small building blocks
20. Paper plates

C. *Key Vocabulary:*
1. Micro-gravity
2. Weightlessness
3. Minerals

D. *Procedures/Activities:*
1. Tell students that the environment in space is not friendly to humans, but even in ways that they haven't already thought of.
2. Read and discuss pages 44 – 46 in *Space*, by Mary Kay Carson.
3. Tell students that they are going to conduct several experiments to test the effects of space upon humans.
4. Set up the "Rubber Bones" experiment, and conduct it as stated in Appendix J.
5. Conduct the "Preserve It!" experiment as follows:
   a. Have partners choose and slice up their food into four same-size slices.
   b. Have each pair put one of their slices on a slip of paper with their names. Gather these up and dry them in a low oven for a few hours or about 10 minutes on a low-microwave setting. Just make sure that they are well dried.
   c. Have the students place one of their slices in a plastic bag; wrap another in aluminum foil; and sprinkle the preservative on the third, place it on the wax paper.
   d. Have each pair place their three slices on a paper plate with their names on it.
   e. Ask the students to check the slices the next day, after three days, and after one week.
   f. Have the students make observations and drawings, and answer the questions at the bottom of the observation sheet, Appendix J.

6. Set up "Get a Grip" Experiment as follows:
    a. Stuff the glove with tissue or cotton.
    b. Suit Up! (Put the glove on).
    c. Now try threading the needle, picking up toothpicks, and stacking blocks
    d. Have students answer the questions in Appendix J.
7. After one week, check out the "Rubber Bones" experiment. Answer questions together.

E. *Assessment/Evaluation:*
1. Teacher will evaluate student's participation in Preserve It! And Get a Grip experiments.
2. Teacher will grade and record responses to questions and conclusions

Lesson Twelve: Future Journeys in Space (two days)

A. *Daily Objectives:*
1. Concept Objectives:
    a. Student will be able take recent news articles and information from the internet and design a space station.
    b. The student will include several of the necessary components in his/her design of the space station.
2. Lesson Content:
    a. Necessary components of existing space stations
    b. Knowledge of prior space stations, Mir and Skylab
3. Skill Objectives
    a. The students will be able to name the essential components of a space station.
    b. The students will design a space station.
    c. The student will build a 3-D model of a space station out of scrap materials.

B. *Materials*
1. Computer for Internet exploration of existing space labs: good web sites are: kca.nasa.gov/history/skylab/skylab.htm; and www.shuttle_mir.nasa.gov/ops/mir
2. Recent newspapers and magazines with articles about the International Space Station
3. Paper , Pencils/markers
4. Various scrap materials: such as, cardboard, cardboard tubes, aluminum foil, clay, plastic soft-drink bottles,
5. Tape and Scissors

C. *Key Vocabulary*
1. none

D. *Procedures/Activities:*
1. Read and discuss any pertinent materials on Mir and Skylab and the International Space Station
2. Discuss the components of the space stations that are necessary to sustain life.
3. Divide class into pairs.
4. Explain that each pair is being given the opportunity to design and build their own space station.
5. Ask students to bring in scrap materials that they could build their stations out of.
6. When complete, the student will present his/her space station to the class.

E. *Assessment/Evaluation:*
1. Teacher will evaluate group cooperation of students.
2. Teacher will grade effort, originality, and creativity of finished space stations.

VI. CULMINATING ACTIVITY

A. Students will give a 3 – 5 minute oral presentation on a biography of someone that interests them who is connected to the field of astronomy or space. Display boards and props are encouraged, along with creativity and originality.

B. Students are expected to take two tests during the unit. Some of the material in these exams was included in the longer term than these lessons cover, but I have included the Study Guides for the students' preparation for the tests. These are Appendixes K and L.

VII. HANDOUTS/WORKSHEETS

Appendixes A - L

VIII BIBLIOGRAPHY

Abgliss, Sarah. *Cosmic Journeys*. Brookfield,CT, Millbrook Press,1998. ISBN 0-7613-0635-8

Bond, Peter. *Guide to Space*. New York: DK Publishing,1999. ISBN 0-7894-3946-8

Butterfield, Moira. *Look Inside Cross-Sections ,Space*. New York: Dorling KindersleyPublishing,Inc., 1994. ISBN 1- 56458-682-0

Carson, Mary Kay. *Space*. New York: Scholastic,Inc., 1996. ISBN 0-590-60344-2

DeWeese,Bob. *Earth, Sun and Moon*. Monteray, CA: Evan-Moor Corp.,1994.

Hawks, Nigel & Pang, Alex. *The Fantastic Cutaway Book of Spacecraft*. Brookfield,CT: Millbrook Press,1995. ISBN 1-56294-903-9

Hirsch, Jr. E.D. *What Your Sixth Grader Needs to Know.* New York: Doubleday,1996.

LaFontaine, Bruce. *Exploring the Solar System* . Mineola, New York: Dover Publications, 1998.ISBN 0-486-40361-0

Levy, David H. *Stars and Planets*. San Francisco: Time Life,1996. ISBN 0-8094-9246-6

Milliken, Linda. *Solar System Activity Book*. Dana Point, CA: Edupress,Inc,1998. ISBN 1-56472-024-8

Ortleb, Edward P. & Cadice, Richard. *The Solar System.* St. Louis, MO: Milliken Publishing Co., 1986.

Pofahl, Jane. *Space Exploration.* Grand Rapids, MI: Instructional Fair, 1999. ISBN 1-568222-799-X

Scagell, Robin. *The New Book of Space.* Brookfield, CT: Alladin Books, 1997. ISBN 0-7613-0619-6

Simon, Sarina. *Space:Amazing Facts Activity Fun Book*. New York: Playmore Inc,1988

Sprigle-Adair, Joan G. & Zahn, Kathy. *Our Solar System.* Torrance, CA: Good Apple,1997. ISBN1-56417-961-3.

Stark, Rebecca. *Our Solar System.* Hawthorne, NY: Educational Impressions, Inc, 2000. ISBN 1-56644-50-5

Appendix A

Explaining the motion of the planets brought about one of the most important disputes in the history of science. This involved two important theories – one suggested by Greek astronomer named Ptolemy in A.D.150 and one suggested in 1543 by Polish astronomer Nicholas Copernicus.

Write about each theory below. Include which one astronomers believe in today.

Ptolemy's theory_____
_____
_____
_____
_____

Copernicus' theory_____
_____
_____
_____
_____

Appendix B

Scale of the Solar System

Use the scale below to create a model of the planets' relative distances from the Sun. You can mark the distances on a fairly clear wall, and tape the planet models and name tags near the marks, or you can hang them from the ceiling. Use the planet patterns with the distance chart, but know that they are NOT to scale with the distances.

Planet	From Model Sun	Actual Miles from Sun
Mercury	1.5 in.	35,898,000
Venus	3 in.	67,084,000
Earth	4 in.	92,752,000
Mars	6 in.	141,575,000
Jupiter	21 in	482,546,000
Saturn	3 ft. 2.5 in.	884,763,000
Uranus	6 ft. 5.5 in.	1,785,000,000
Neptune	10 ft. 1 in	2,797,892,000
Pluto	13 ft. 3 in.	3,633,700,000

Diameters of planet patterns:

Mercury- .5cm
Venus- 1cm
Earth- 1cm
Mars- .75cm
Jupiter- 12cm
Saturn- 10cm
Uranus- 4.5cm
Neptune- 4.2cm
Pluto- 3mm
Sun – draw a circle with a diameter 9 and ½ times bigger than that of Jupiter

Appendix C
Planetary Syllogisms

A syllogism is a type of deductive reasoning. It is based two premises and a conclusion. In a valid argument, the conclusion must agree with the previous statements, and be based upon them.

Decide whether each of the following arguments is valid or invalid and write the appropriate word. If invalid, explain why.

! A. Planets do not emit self-generated light; they are illuminated by the star around which they revolve.
B. Mars is a planet.
C. Therefore, Mars does not emit self-generated light.

---

2. A. Most planets have a moon which orbit them.
A. Saturn is a planet.
B. Therefore, Saturn is a planet.

---

3. A. Pluto is the smallest planet in our solar system.
B. Earth is a planet in our solar system.
C. Therefore, Earth is larger than Pluto.

Now create four syllogisms about the solar system. Exchange with classmates to solve.

1. A._____
B._____
C._____

2. A._____
B._____
C._____

3. A._____
B._____
C._____

4. A._____
B._____
C._____

Appendix D

Gravity Worksheet

Station 1: Investigating Falling

Materials: metal tray and objects in each set: a: ball bearing and marble of same size
b: sugar cube and a die
c: sponge ball and tennis ball

Procedure:
1. Place tray on floor, and stand on a chair above tray
2. Hold two objects in a set in each hand
3. Hold the objects as high as you can and drop them onto the tray at the same time
4. Listen for the sound of them hitting the tray

Results:	Name of object that hit first	Name of object that hit second
Set 1		
Set 2		
Set 3		

Observations/Conclusions:
1. What effect does mass(weight) of an object have in relation to gravity?_____
_____

2. Explain why the objects in each set were used together._____
_____

Station 2: Hitting the Ground

Materials: marble, ruler, metal tray with clay spread on the bottom
Procedure:
1. Drop the marble into the clay from different heights. Try 1 foot, 2 feet, 3 feet, etc.
2. Measure the size of the dent in the clay each time with the ruler and record the results.

Observations:

Distance	Size of the Dent
1 foot	
2 feet	
3 feet	
4 feet	
5 feet	

Make a graph of your results.

What happens as you drop the object from greater heights?

Appendix E

Create Your Own Constellation

Make up your own constellation. What is its name?

Draw a picture in this box.

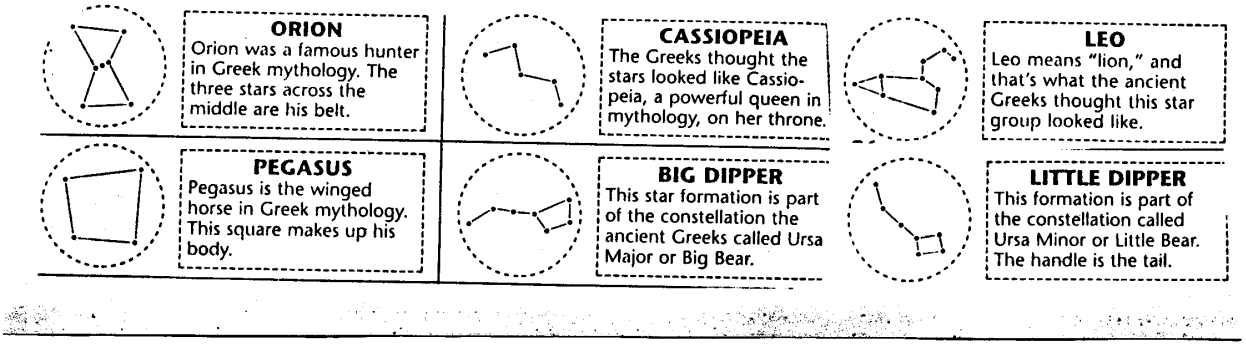
Use these lines to write a myth about how your constellation got its name:

_____
_____
_____
_____
_____

Appendix F

Directions for Film Canister Constellations:

1. Carefully cut out a pattern for a constellation. Tape the information label onto the side of the canister.
2. Take off the lid and fit the pattern inside the lid. Place on piece of thick cardboard disk-side up and using the sewing needle, carefully poke holes where the dots are.
3. Take the pattern out and make sure the hole went all the way through by holding it up to the light.
4. Turn the film canister upside down and make a hole with the nail in the center big enough to fit an unsharpened pencil in it.
5. Put the lid on the canister and hold it up to the light. What do you see?
6. Repeat steps 1-6 with the other disks and film canisters.



Appendix F

Star Struck Directions

Materials: star stickers, resource books or maps of constellations, paper

Directions:

1. Use the star stickers to recreate several constellations.
2. Place stickers at appropriate places on the black construction paper.
3. Connect the stars with glitter gel pen or chalk.

Mini Maps of the Stars Directions

Materials: Black construction paper, gel pen or chalk, stapler, resource books or map of constellations, straight pin, cardboard

Directions:

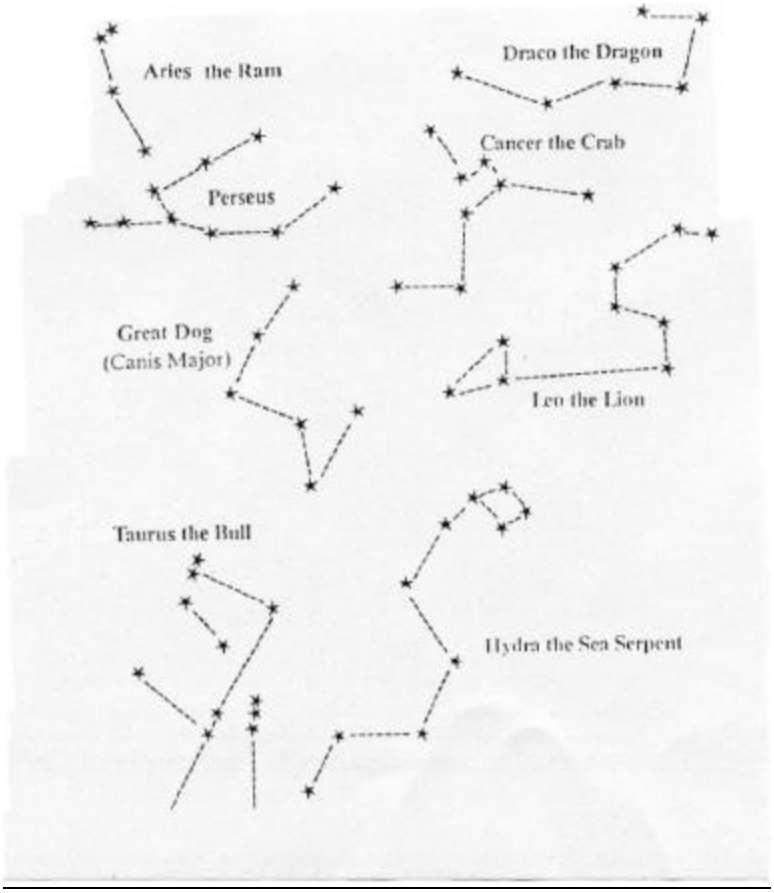
1. Reproduce a copy for each student of the constellation pattern page
2. Staple pattern page to black construction paper
3. Working on a soft carpeted surface,(or cardboard) poke the straight pin through all the lines connecting the stars. Each hole should be very close to the one next to it. Several holes should be made at the location of a star.
4. When all the lines are complete, turn the paper over. Looking through the black side, hold the paper up to the light to reveal mini-constellations.

(We taped several of our mini-maps onto our windows, and they we fun to look at!)

Appendix G

Constellation Patterns

(enlarge these to fit construction paper)



Appendix H

Astronomer Discovery Cards

STELLAR ASTRONOMER

- You've discovered a way to bottle star light and create unusual new products.
- A star has been discovered closer to Earth than any other. Are there any dangers?
- A star has disappeared, what has happened to it?
- A new constellation has been discovered. Name and describe it.

PLANETARY ASTRONOMER

- You've discovered life on another planet.
- A huge comet is headed to Mars. What will happen?
- What information can you give on a new planet that has been discovered in a high-powered telescope.
- Amazing new features have been discovered on Venus!

SOLAR ASTRONOMER

- New spots have appeared on the surface of the sun. What are they?
- A new way has been discovered to test the sun's temperature.
- The size of the sun is changing! What will the effects be here on Earth?
- The core of the sun has been changing. What observations have been recorded?

Appendix I

Rockets and Rocket Flight Chart

Direction for Making Rockets:

1. Roll a paper strip around the pencil. Tape the tube in three places
2. Remove the pencil. Cut off the ends. Fold over the upper end and tape shut. Repeat steps 1-3.
3. Cut out the fins. Fold out the tabs and tape tp one of the tubes.
4. Prepare to launch! Choose a target(chair or piece of tape on floor), Mark the launching place about 10-15 steps away from the target, and mark the Launch Site with tape.
5. Slip the straw into rocket without the fins and blow. Leave rocket where it lands.
6. Now launch other rocket from the same spot. Measure the distances, and record in chart. Repeat 7-9 more times.

Rocket Flight Chart

Launch	Rocket A (without fins)	Rocket B (with fins)	Rocket C (your own design)
First Launch			
Second Launch			
Third Launch			

Did rocket A or B come closer to the target?_____

What do you think the fins are for?_____

_____

_____

_____

Appendix J

Surviving in Space

1. Rubber Bones

Directions for Experiment:

Materials: two similar cleaned chicken bones, jar with kid, white vinegar

Procedure:

1. Place one bone in the jar and pour enough vinegar into jar to cover it. Leave the other bone uncovered on a plate.
2. Screw lid on tightly.
3. After at least a week, take the bone out and dry it off.
4. Have students compare it to the untreated chicken bone.

Discussion Questions:

What makes bones generous?

How are the two bones different?

What do you think happened?

How is this like what happens to bones in space?

2.Preserve It!

Preserver	After 1 day	After 3 days	After a week
Foil			
Plastic Bag			
Dried			
Preservative			

Which preserver left your food OK to eat after a week?

Which preserver do you think would be best for space food? Why?

3. Get A Grip!

What did the spaceglove feel like?

What exactly was hard to do with the spaceglove on?

How could you change the blocks so they'd be easier to stack "in space"?