**Introduction: Your Mission, Choose Your Planet**

Time: approximately 40 - 50 minutes
Materials: Copies of Planet Preference Survey (from web site – 1 per group)
         Text: Choose Your Own Planet (from web site – 1 per student)
         Two-pocket folders (1 per group)

**Overview**

This lesson introduces the class to the goals for the 2nd part of this unit. Students will learn the basic characteristics of stars and planets. The lesson can be split into 2 shorter lessons of approximately 20-25 minutes each.

**Purpose**

Students will have a greater interest in the lessons that follow because they will be able to see how their own planet, and the possible success of their “mission,” is impacted by the different climate influences. The opportunity to choose the criteria of the planet they will be investigating gives the groups a personal connection to the material.

**Standards**

This lesson is designed to cover science standards in the areas of Scientific Inquiry and the Universe. A complete list is included at the end of this lesson in the Appendix.

**Procedure**

**Note:** Over the course of “Build Your Own Planet” students will complete several worksheets and other assignments. It is important that all the work completed for this half of the unit be kept together. Teachers might want to give each group a folder to keep all their materials in and have the mission recorder or group commander be responsible for it. An alternative to folders is to print out and copy all the lessons and staple or bind them together.

**Step 1: Groups**

The remainder of this unit requires that students work in groups of 4. When the class can not be divided evenly, groups of 3 are preferred over groups of 5. The teacher should choose how to create and assign groups, but all groups should have at least one crew member who is capable of following and articulating directions.

After the groups have been formed and announced, students should get into their groups and elect a commander, an engineer, a technician and a mission recorder (or these roles can be assigned). In groups of 3 the roles of engineer and technician can be combined. If groups of 5 are used the role of mission recorder
can be split into 2 separate positions—mission recorder and communications officer.

The roles of the different positions are described in the text “Choose Your Own Planet.” Students should read the section titled “Your Mission” and decide positions. Make sure that each group knows what roles they must assign. You might want to take the time to have the different roles read aloud:

**Technician:** The technician is responsible for all the equipment. She or he will get the supplies from the teacher and bring them to the group. It is the technician’s responsibility to make sure that all supplies and equipment are used correctly, to report any damaged or missing supplies to the teacher, and to return all equipment and supplies when the crew has completed a lesson. When there are fewer than 4 crew members, the technician will also do the engineer’s job.

**Engineer:** The engineer is responsible for computing. When the crew needs to use computers to complete a lesson, the engineer will enter any necessary information into the computer and report the results back to the crew.

**Mission Recorder:** The mission recorder will keep track of the results of all the experiments performed by the crew. He or she is responsible for recording the group’s discoveries, conclusions and opinions on the forms and worksheets that the crew works on during this mission. When there are fewer than 5 crew members, the mission recorder will also do the communications officer’s job.

**Communications Officer:** The communications officer will speak for the crew to people back on Earth. This person will report the results of different experiments performed and any discoveries made by the crew. They will need to listen to the other crew members’ ideas and summarize them when reporting to class.

**Group Commander:** The group commander’s responsibility is to ensure that the mission is completed successfully. The commander must ensure that the other group members have a say in all decisions. She or he will see that all instructions are read to and understood by the other group members. The commander must make sure that the other group members perform their responsibilities and may need to fill in for other members when they are missing. Finally, the commander may need to make final decisions if the group cannot agree. The group commander should be well respected by the other group members, make good decisions and be able to inspire the other group members to give their best efforts.

Students will decide roles and record them on their worksheets. They should also choose and record a name for their group.

**Step 2: Planets**
Part 2: Build Your Own Planet

Next the students must decide the physical characteristics of the planet that they will be exploring. Have the class read the introduction to this section.

Now that your crew is assembled you need to decide what type of planet or moon you want to explore. You will use the Planet Preference Survey to select different physical characteristics of your planet.

There are several things you need to think about as you make your selections. Recall that water can exist as a solid (ice), a liquid or a gas (water vapor). Most scientists think that all living things need some water in a liquid state in order to survive. Since your goal is to discover life, you will want to find liquid water somewhere on the planet that you explore. On Earth water is usually a liquid between 0ºC and 100ºC, or 32ºF and 212ºF, so you might want to explore a planet with an average surface temperature in this range.

However, you don’t want your planet to be an exact copy of Earth. How difficult can it be to discover life on a planet like Earth? Anyone can do that! The planet you explore will be dozens of light years away. If you are going to travel that far, you might as well make it a little challenging. The trick will be to make your planet enough like Earth to make life on it a possibility but different enough from Earth to make traveling that far to explore it worth the effort.

There are 6 physical characteristics of their planet that the students must decide on. Have the class read the explanation to question number 1 and then decide on the type of Sun their planet will orbit.

Question #1: What type of star will your planet orbit?

Stars produce most of their energy by smashing hydrogen atoms together to form helium atoms. The size of the star determines how much energy it gives off and long it lasts.

Stars have life cycles. They are born, live for a while giving off heat and light, and then die violent deaths. Low mass stars do not give off as much heat as larger stars, but they last a long time, tens to hundreds of billions of years. Solar type stars are similar to our Sun. They are more massive than low mass stars but less massive than high mass stars. These stars are very common in our galaxy. They give off more heat than low mass stars but they do not last as long. Our Sun, for example, has a total life span of around 10 billion years. High mass stars give off the most heat, but they do not last very long. Usually their total life cycle is less than 1 billion years, sometimes much less. Earth is 4.6 billion years old. If we were orbiting a high mass star, our Sun would have burnt out over 3.5 billion years ago.

Decide with your group which type of star you would like to orbit and mark your choice on the Planet Preference Survey.
Have the class read the notes for question #2 and then decide the age of their star:

**Question #2: What is the age of the star you are orbiting, in billions of years?**

Most astronomers think that the Earth formed fairly quickly after the birth of the Sun. You should assume that your planet is almost, but not exactly, the same age as your star. Decide with your group how old your star is and mark your choice on the Planet Preference Survey. You may enter a fraction or a decimal if you want your star to be less than 1 billion years old. For example, if your planet is 200 million years old you would enter 0.2, because 0.2 times 1 billion equals 200 million. Your star can not be over 13.6 billion years old, however, because our universe is only 13.7 billion years old and there are no stars older than 13.6 billion years old.

Continue in this fashion with the remaining questions of this assignment:

**Question #3: How far from your star is your planet?**

Decide with your group how far from your star your planet will be and mark your choice on the Planet Preference Survey. Keep in mind that moving farther away from your star will make your planet colder, assuming all other factors are the same. That is why Pluto, which is 40 times as far away from the Sun as Earth, is so much colder than Earth.

**Question #4: What type of object do you want to explore?**

Examples of the different types of objects are given. A brown dwarf is a large, gaseous object almost, but not quite, massive enough to become a star. It gives off some light and heat, but very little—not enough to warm a moon or planet. Currently we do not know of any moons orbiting brown dwarfs, but there’s no reason why moons can’t orbit them. Decide with your group which type of object you would most like to explore and mark your choice.

**Question #5: What type of surface do you want on your planet?**

**Question #6: What type of atmosphere do you want?**

Both the surface and the atmosphere have an effect on the average surface temperature of your planet. We will look more closely at how they affect it in later lessons. For now, just decide which you think would be the most interesting to explore and mark your choice.

The groups will be using their Planet Preference Surveys for many of the lessons in this section. Later, in Lesson 5, groups will have an opportunity to
change any one of the choices they made on this survey, but groups should not change any of their choices before then. Since future lessons will refer to this Survey, it is important that they do not get lost or destroyed. Teachers might want to collect and photocopy them and pass the copies back to the groups, holding on to the originals in case they are needed.
Appendix

**Standards Addressed**

**Benchmarks (Grades 3 through 5)**

1B – Scientific Inquiry

*Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. Investigations can focus on physical, biological, and social questions.*

1C – Scientific Enterprise

*Science is an adventure that people everywhere can take part in, as they have for many centuries.*

*Doing science involves many different kinds of work and engages men and women of all ages and backgrounds.*

4A – The Universe

*Stars are like the Sun, some being smaller and some larger, but so far away that they look like points of light.*

4B – The Earth

*When liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point of water. Clouds and fog are made of tiny droplets of water.*

7D – Social Trade-Offs

*In making decisions, it helps to take time to consider the benefits and drawbacks of alternatives.*

*In making decisions, benefits and drawbacks of alternatives can be taken into account more effectively if the people who will be affected are involved.*

*Sometimes social decisions have unexpected consequences, no matter how carefully the decisions are made.*

7E – Political and Economic Systems

*Some jobs require more (or more expensive) training than others, some involve more risk, and some pay better.*

7F – Social Conflict

*Communicating the different points of view in a dispute can often help people to find a satisfactory compromise.*

*If a conflict cannot be settled by compromise, it may be decided by a vote—if everyone agrees to accept the results.*
11A – Systems
*In something that consists of many parts, the parts usually influence one another.*

12A – Values and Attitudes
*Keep records of their investigations and observations and not change the records later.*

**Benchmarks (Grades 6 through 8)**

1C – Scientific Enterprise
*No matter who does science and mathematics or invents things, or when or where they do it, the knowledge and technology that result can eventually become available to everyone in the world.*

3A – Technology and Society
*Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.*

*Engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems. But they usually have to take human values and limitations into account as well.*

3C – Issues in Technology
*The human ability to shape the future comes from a capacity for generating knowledge and developing new technologies—and for communicating ideas to others.*

4A – The Universe
*The sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars, part of which can be seen as a glowing band of light that spans the sky on a very clear night. The universe contains many billions of galaxies, and each galaxy contains many billions of stars. To the naked eye, even the closest of these galaxies is no more than a dim, fuzzy spot.*

4B – The Earth
*Fresh water, limited in supply, is essential for life and also for most industrial processes. Rivers, lakes, and groundwater can be depleted or polluted, becoming unavailable or unsuitable for life.*

4E – Energy Transformation
*Most of what goes on in the universe—from exploding stars and biological growth to the operation of machines and the motion of people—involves some form of energy being transformed into another. Energy in the form of heat is almost always one of the products of an energy transformation.*

7D – Social Trade-Offs
*Tradeoffs are not always between desirable possibilities. Sometimes social and personal tradeoffs require accepting an unwanted outcome to avoid some other unwanted one.*
7F – Social Conflict
Most groups have formal or informal procedures for arbitrating disputes among their members.

7G – Global Interdependence
Scientists are linked to other scientists worldwide both personally and through international scientific organizations.

11A – Systems
Thinking about things as systems means looking for how every part relates to others. The output from one part of a system (which can include material, energy, or information) can become the input to other parts. Such feedback can serve to control what goes on in the system as a whole.

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

4B – The Earth
Life is adapted to conditions on the earth, including the force of gravity that enables the planet to retain an adequate atmosphere, and an intensity of radiation from the sun that allows water to cycle between liquid and vapor.

7D – Social Trade-Offs
Benefits and costs of proposed choices include consequences that are long-term as well as short-term, and indirect as well as direct. The more remote the consequences of a personal or social decision, the harder it usually is to take them into account in considering alternatives. But benefits and costs may be difficult to estimate.

11A – Systems
Even in some very simple systems, it may not always be possible to predict accurately the result of changing some part or connection.

National Standards (Grades 5-8)
Transfer of Energy
The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

Science and Technology in Society
Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, specific research institutes, and government agencies.

Science as a Human Endeavor

Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.

Science requires different abilities, depending on such factors as the field of study and type of inquiry. Science is very much a human endeavor, and the work of science relies on basic human qualities, such as reasoning, insight, energy, skill, and creativity—as well as on scientific habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

National Standards (Grades 9-12)

Understandings about Scientific Inquiry

Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.

Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.

Results of scientific inquiry—new knowledge and methods—emerge from different types of investigations and public communication among scientists. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge. In addition, the methods and procedures that scientists used to obtain evidence must be clearly reported to enhance opportunities for further investigation.

The Origin and Evolution of the Universe

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

Understandings about Science and Technology

Scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations. Many scientific investigations require the contributions of individuals from different disciplines, including engineering. New disciplines of science, such as geophysics and biochemistry often emerge at the interface of two older disciplines.
Science as a Human Endeavor

Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Doing science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding.

Indiana Standards

Grade 5

**English/Language Arts – Decoding and Word Recognition**

5.1.1 – Read aloud grade-level-appropriate narrative text (stories) and expository text (information) fluently and accurately and with appropriate timing, changes in voice, and expression.

**Science – The Scientific Enterprise**

5.1.3 – Explain that doing science involves many different kinds of work and engages men, women, and children of all ages and backgrounds.

The Universe

5.3.2 – Observe and describe that stars are like the sun, some being smaller and some being larger, but they are so far away that they look like points of light.

Systems

5.6.1 – Recognize and describe that systems contain objects as well as processes that interact with each other.

Social Studies – Roles of Citizens

5.2.9 – Demonstrate civic responsibility in group and individual actions, including civic dispositions — such as civility, cooperation, respect, and responsible participation.

Grade 6

**English/Language Arts – Decoding and Word Recognition**

6.1.1 – Read aloud grade-level-appropriate narrative text (stories) and expository text (information) fluently and accurately and with appropriate timing, changes in voice, and expression.

**Science – Interdependence of Life and Evolution**

6.4.10 – Describe how life on Earth depends on energy from the Sun.

Grade 7

**Science – The Universe**

7.3.1 – Recognize and describe that the sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars and that the universe contains many billions of galaxies and each galaxy contains many billions of stars.
Matter and Energy
7.3.11 – Explain that the sun loses energy by emitting light. Note that only a tiny fraction of that light reaches Earth. Understand that the sun’s energy arrives as light with a wide range of wavelengths, consisting of visible light and infrared and ultraviolet radiation.

Grade 8
Science – Communication
8.2.7 Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.

Matter and Energy
8.3.14 – Describe how heat can be transferred through materials by the collision of atoms, or across space by radiation, or if the material is fluid, by convection currents that are set up in it that aid the transfer of heat.

Systems
8.7.2 – Explain that even in some very simple systems, it may not always be possible to predict accurately the result of changing some part or connection.

Earth and Space Science
ES.1.2 – Differentiate between the different types of stars found on the Hertzsprung-Russell Diagram. Compare and contrast the evolution of stars of different masses. Understand and discuss the basics of the fusion processes that are the source of energy of stars.

ES.1.3 – Compare and contrast the differences in size, temperature, and age between our sun and other stars.

ES.1.6 – Discuss how manned and unmanned space vehicles can be used to increase our knowledge and understanding of the universe.