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| **Lesson 3.1 Space Travel** |

**Preface**

Space is considered a resource for the benefit all of humankind. This resource is protected and its development is coordinated through a system of agreements between many nations and disputes are resolved through the application of Space Law.

After gaining the approval of the United Nations Office of Outer Space then a voyage into Space can begin. Space travel requires a complex system with many highly skilled people working together to lower the risk of mishap.

In this lesson students will gain a perspective of the immense scale of the universe. Students will also explore the growing space debris problem and design a mitigation system.

**Concepts**

1.     The universe exists in a scale that is difficult to conceptualize.

2.     Space law is a system based on international agreements designed to promote the use of space for the good of all humankind.

3.     The exploration of space is successful through learning from previous missions and the development of technology and systems.

**Standards and Benchmarks Addressed**

***Standards for Technological Literacy***

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| **Standard 1:  Students will develop an understanding of the characteristics and scope of technology.** |
| **BM J:** | The nature and development of technological knowledge and processes are functions of the setting. |
| **BM K:** | The rate of technological development and diffusion is increasing rapidly.  |
| **BM L:** | Inventions and innovations are the results of specific, goal-directed research. |
| **BM M:** | Most development of technologies these days is driven by the profit motive and the market. |
| **Standard 2:  Students will develop an understanding of the core concepts of technology.** |
| **BM W:** | Systems’ thinking applies logic and creativity with appropriate compromises in complex real-life problems.  |
| **BM X:** | Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems.  |
| **BM Y:** | The stability of a technological system is influenced by all of the components in the system especially those in the feedback loop.  |
| **BM Z:** | Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.  |
| **BM AA:** | Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.  |
| **BM BB:** | Optimization is an on going process or methodology of designing or making a product and is dependent on criteria and constraints. |
| **BM CC:** | New technologies create new processes.  |
| **BM DD:** | Quality control is a planned process to ensure that a product, service, or system meets established criteria.  |
| **BM EE:** | Management is the process of planning, organizing, and controlling work.  |
| **BM FF:** | Complex systems have many layers of controls and feedback loops to provide information. |
| **Standard 3:  Students will develop an understanding of the relationships** **among technologies and the connections between technology and other fields of study.** |
| **BM G:** | Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function |
| **BM H:** | Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields.  |
| **BM I:** | Technological ideas are sometimes protected through the process of patenting. The protection of a creative idea is central to the sharing of technological knowledge. |
| **BM J:** | Technological progress promotes the advancement of science and mathematics. Likewise, progress in science and mathematics leads to advances in technology. |
| **Standard 4:  Students will develop an understanding of the cultural, social, economic, and political effects of technology.** |
| **BM H:** | Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.  |
| **BM I:** | Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.  |
| **BM J:** | Ethical considerations are important in the development, selection, and use of technologies.  |
| **BM K:** | The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees. |
| **Standard 5:  Students will develop an understanding of the effects of** **technology on the environment.** |
| **BM H:** | When new technologies are developed to reduce the use of resources, considerations of trade-offs are important.   |
| **BM J:** | The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.  |
| **BM K:** | Humans devise technologies to reduce the negative consequences of other technologies.  |
| **BM L:** | Decisions regarding the implementation of technologies involve the weighing of tradeoffs between predicted positive and negative effects on the environment. |
| **Standard 6:  Students will develop an understanding of the role of society in the development and use of technology.**  |
| **BM H:** | Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.  |
| **BM I:** | The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures.   |
| **BM J:** | A number of different factors, such as advertising, the strength of the economy, the goals of a company and the latest fads contribute to shaping the design of and demand for various technologies. |
| **Standard 7:  Students will develop an understanding of the influence of** **technology on history.**  |
| **BM G:** | Most technological development has been evolutionary, the result of a series of refinements to a basic invention.  |
| **BM H:** | The evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools and materials.  |
| **BM I:** | Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape.  |
| **BM J:** | Early in the history of technology, the development of many tools and machines was based not on scientific knowledge but on technological know-how.  |
| **BM O:** | The Information Age places emphasis on the processing and exchange of information. |
| **Standard 8:  Students will develop an understanding of the attributes of design.**  |
| **BM H:** | The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.   |
| **BM I:** | Design problems are seldom presented in a clearly defined form.  |
| **BM J:** | The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.   |
| **BM K:** | Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. |
| **Standard 9:  Students will develop an understanding of engineering design.**  |
| **BM I:** | Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.  |
| **BM J:** | Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. |
| **BM K:** | A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.  |
| **BM L:** | The process of engineering design takes into account a number of factors. |
| **Standard 10:  Students will develop an understanding of the role of** **troubleshooting, research and development, invention and innovation, and experimentation in problem solving.** |
| **BM I:** | Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.  |
| **BM J:** | Technological problems must be researched before they can be solved.  |
| **BM K:** | Not all problems are technological, and not every problem can be solved using technology.  |
| **BM L:** | Many technological problems require a multidisciplinary approach. |
| **Standard 11:  Students will develop abilities to apply the design process.**  |
| **BM M:** | Identify the design problem to solve and decide whether or not to address it. |
| **BM N:** | Identify criteria and constraints and determine how these will affect the design process.   |
| **BM O:** | Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.   |
| **BM P:** | Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.   |
| **BM Q:** | Develop and produce a product or system using a design process.    |
| **BM R:** | Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. |
| **Standard 12:  Students will develop the abilities to use and maintain technological products and systems.**  |
| **BM L:** | Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.  |
| **BM P:** | Use computers and calculators to access, retrieve, organize and process, maintain, interpret, and evaluate data and information in order to communicate. |
| **Standard 13:  Students will develop the abilities to assess the impacts of products and systems.**  |
| **BM J:** | Collect information and evaluate its quality.  |
| **BM K:** | Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment.   |
| **BM L:** | Use assessment techniques, such as trend analysis and experimentation to make decisions about the future development of technology.   |
| **BM M:** | Design forecasting to evaluate the results of altering natural systems. |
| **Standard 16:  Students will develop an understanding of and be able to select and use energy and power technologies.**  |
| **BM J:** | Energy cannot be created or destroyed; however, it can be converted from one form to another. |
| **BM K:** | Energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others.   |
| **BM L:** | It is possible to build an engine to perform work that does not exhaust thermal energy to the surroundings.   |
| **BM M:** | Energy resources can be renewable or nonrenewable. |
| **BM N:** | Power systems must have a source of energy, a process, and loads. |
| **Standard 17:  Students will develop an understanding of and be able to select and use information and communication technologies.**  |
| **BM L:** | Information and communication technologies include the inputs, processes, and outputs associated with sending and receiving information. |
| **BM M:** | Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine.  |
| **BM N:** | Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.  |
| **BM O:** | Communication systems are made up of source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination. |
| **BM P:** | There are many ways to communicate information, such as graphic and electronic means. |
| **BM Q:** | Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli. |
| **Standard 18:  Students will develop an understanding of and be able to select and use transportation technologies.**  |
| **BM J:** | Transportation plays a vital role in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture.  |
| **BM K:** | Intermodalism is the use of different modes of transportation, such as highways, railways, and waterways as part of an interconnected system that can move people and goods easily from one mode to another.   |
| **BM L:** | Transportation services and methods have led to a population that is regularly on the move.   |
| **BM M:** | The design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques. |
| **Standard 19:  Students will develop an understanding of and be able to select and use manufacturing technologies.**  |
| **BM L:** | Servicing keeps products in good operating condition.  |
| **BM M:** | Materials have different qualities and may be classified as natural, synthetic, or mixed.   |
| **BM P:** | The interchangeability of parts increases the effectiveness of manufacturing processes.   |
| **BM Q:** | Chemical technologies provide a means for humans to alter or modify materials and to produce chemical products.   |
| **BM R:** | Marketing involves establishing a product’s identity, conducting research on its potential, advertising it, distributing it, and selling it. |

***National Science Education Standards***

**Unifying Concepts and Processes:**  As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes.

        **Systems, order, and organization**

        **Evidence, models, and explanation**

        **Change, constancy, and measurement**

        **Form and function**

**Science As Inquiry Standard A:** As a result of activities in grades 9-12, all students should develop

        **Understanding about scientific inquiry**

**Physical Science Standard B:** As a result of activities in grades 9-12, all students should develop an understanding of

        **Motions and forces**

        **Conservation of energy and increase in disorder**

        **Interactions of energy and matter**

**Earth and Space Science Standard D:** As a result of activities in grades 9-12, all students should develop an understanding of

        **Energy in the earth system**

        **Origin and evolution of the earth system**

        **Origin and evolution of the universe**

**Science and Technology Standard E:** As a result of activities in grades 9-12, all students should develop

        **Abilities of technological design**

        **Understandings about science and technology**

**Science in Personal and Social Perspectives Standard F:** As a result of activities in grades 9-12, all students should develop understanding of

        **Personal and community health**

        **Population growth Natural resources**

        **Environmental quality**

        **Natural and human-induced hazards**

        **Science and technology in local, national, and global challenges**

**History and Nature of Science Standard G:** As a result of activities in grades 9-12, all students should develop understanding of

        **Science as a human endeavor**

        **Nature of scientific knowledge**

        **Historical perspectives**

***Principles and Standards for School Mathematics***

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| **Number and Operations** | Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; compute fluently and make reasonable estimates. |
| **Algebra** | Instructional programs from pre-kindergarten through grade 12 should enable all students to understand patterns, relations, and functions; represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships; analyze change in various contexts. |
| **Geometry** | Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships; specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; use visualization, spatial reasoning, and geometric modeling to solve problems. |
| **Problem Solving** | Instructional programs from pre-kindergarten through grade 12 should enable all students to build new mathematical knowledge through problem solving; solve problems that arise in mathematics and in other contexts; apply and adapt a variety of appropriate strategies to solve problems; monitor and reflect on the process of mathematical problem solving. |
| **Communication** | Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; analyze and evaluate the mathematical thinking and strategies of others; use the language of mathematics to express mathematical ideas precisely. |
| **Connections** | Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and use connections among mathematical ideas; understand how mathematical ideas interconnect and build on one another to produce a coherent whole; recognize and apply mathematics in contexts outside of mathematics. |
| **Representation** | Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representations to solve problems; use representations to model and interpret physical, social, and mathematical phenomena. |

***Standards for English Language Arts***

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| **Standard 1** | Students read a wide range of print and non-print texts to build an understanding of texts of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classical and contemporary works. |
| **Standard 2** | Students read a wide range of literature from many periods in many genres to build an understanding of the many dimensions (e.g. philosophical, ethical, aesthetic) of human experience |
| **Standard 4** | Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes. |
| **Standard 5** | Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes. |
| **Standard 7** | Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g. print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience. |
| **Standard 8** | Students use a variety of technological and informational resources (e.g. libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge. |
| **Standard 9** | Students develop an understanding of and respect for diversity in language use, patterns, and dialects across cultures, ethnic groups, geographic regions, and social roles. |

**Performance Objectives**

*It is expected that students will:*

       Describe the relative sizes of celestial bodies.

       Apply space law to an accident involving space hardware.

       Explain how technology development is intertwined into the culture of a nation.

       Design a space junk mitigation system.

**Assessment**

*Explanation*

       Students will explain how space junk effects space travel.

*Interpretation*

       Students will use space law to determine how an issue would be judged in an international court.

*Application*

       Students will design a protection system prototype for a space craft.

*Perspective*

       Students will argue differences in opinion for space laws.

*Empathy*

       Students will demonstrate how the space race affects cultures.

**Essential Questions**

1.     What is the universe?

2.     How old is the universe?

3.     Why do we have space law?

4.     Why is space junk so dangerous?

**Key Terms**

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| **Term** | Definition |
| **Asteroids** | Small bodies composed of rock and metal in orbit about the sun. |
| **Comets** | Small bodies composed of ice and rock in various orbits about the sun. |
| **ESA** | European Space Agency. |
| **Galaxy** | An assembly of stars and related matter and gas, all heldtogether by mutual gravity. |
| **Kessler Syndrome** | A prediction of a future cascading of collisions in orbit. |
| **Light-year** | The distance that light travels in one year, about 6 trillion miles. |
| **Moon** | A natural satellite of a planet. |
| **NGO** | Non-Government Organizations. |
| **Planet** | An orbiting body large enough to become round by the force of its own gravity and large enough to dominate the vicinity of its orbit. |
| **Satellite** | A small body which orbits a larger one. A natural or an artificial moon. |
| **UN** | United Nations. An organization established on 24 October 1945 by 51 countries committed to preserving peace through international cooperation and collective security. |
| **Universe** | All that we see and cannot see. |

**Day-by-Day Plans**

*Time: 6 days*

**Day 1:**

       The teacher will present **Concepts**, **Key Terms**, and **Essential Questions** in order to provide a lesson overview.

       The teacher will present **What is Space.ppt**while students take notes.

       The teacher will distribute and introduce **Activity 3.1.1 Sizing up the Universe**.

       Students will complete Activity 3.1.1 Sizing up the Universe*.*

**Day 2:**

       The teacher will present **Space Law.ppt**while students take notes.

       The teacher will distribute and introduce **Project 3.1.2 Space Law**.

       The students will complete Project 3.1.2 Space Law*.*

**Day 3:**

       The teacher will present **Race to the Moon.ppt** while students take notes**.**

       The teacher will present **Commercial Human Space Systems.ppt** while students take notes**.**

       Host a class discussion on the transition from government sponsored space travel to commercial participation.

**Day 4-6:**

       The teacher will present **Space Junk.ppt**while students take notes.

       The teacher will distribute and introduce **Project 3.1.3 Space Junk Mitigation**.

       The students will complete Project 3.1.3 Space Junk Mitigation.

       The students will present Project 3.1.3 Space Junk Mitigation.

**Instructional Resources**

Presentations

**What is Space**

**Space Law**

**Race to the Moon**

**Commercial Human Space Systems**

**Space Junk**

Word Documents

**Activity 3.2.1 Sizing Up the Universe**

**Project 3.1.2 Space Law**

**Project 3.1.3 Space Junk Mitigation**