Standard

CT – Physics - Motion and Forces, Conservation of Energy and Momentum, Heat and Thermodynamics

MA- Gr. 6-8 - Earth & Space - #8; Physical - #1,14,16; Tech-2.3,2.4; Various High School Standards in Physics and Technology

Living in Space

Connecticut

Science

Center

Created By:

Michael Ross,
Connecticut Science Center

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Connecticut Science Center | 250 Columbus Blvd, Hartford, CT 06103

Connecticut Science Center

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Summary

While visiting the Science Center, your students may deepen their experience by using Trail Guides as they visit the Exploring Space Galleries to answer questions about High School Earth Science – Earth's Place in the Universe

The complete CT Core Science Curriculum Frameworks is available at the website http://www.sde.ct.gov/sde/cwp/view.asp?a=2618&q=320890. See also: American Association for the Advancement of Science, *Atlas of Science Literacy*, Project 2061.

In addition to discussion of space, investigations into pressure, temperature conduction and convection, gravity, and radiation will be performed by the students.

Following are the specific sections from the CT Core Science Curriculum Framework that are addressed in this unit. The C INQ information reflects the process skills intended for grades 6-8 while the D INQ reflect the process skills intended for grades 9-10, specifically representing the content standards of scientific inquiry, literacy, and numeracy.

Inquiry Standards

Grades 6-8 Core Scientific Inquiry, Literacy and Numeracy *How is scientific knowledge created and communicated?*	
Content Standards	**Expected Performances**
SCIENTIFIC INQUIRY ♦ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. ♦ Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation. ♦ Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists. **SCIENTIFIC LITERACY** ♦ Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science. ♦ Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media. **SCIENTIFIC NUMERACY** ♦ Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.	C INQ.1 Identify questions that can be answered through scientific investigation. C INQ.2 Read, interpret and examine the credibility of scientific claims in different sources of information. C INQ.3 Design and conduct appropriate types of scientific investigations to answer different questions. C INQ.4 Identify independent and dependent variables, and those variables that are kept constant, when designing an experiment. C INQ.5 Use appropriate tools and techniques to make observations and gather data. C INQ.6 Use mathematical operations to analyze and interpret data. C INQ.7 Identify and present relationships between variables in appropriate graphs. C INQ.8 Draw conclusions and identify sources of error. C INQ.9 Provide explanations to investigated problems or questions. C INQ.10 Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Grades 9-10 Core Scientific Inquiry, Literacy and Numeracy	
Content Standards	Expected Performances
SCIENTIFIC INQUIRY ♦ **Scientific inquiry is a thoughtful and** coordinated attempt to search out, describe, explain and predict natural phenomena. ♦ **Scientific inquiry progresses through** a continuous process of questioning, data collection, analysis and interpretation. ♦ Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists. SCIENTIFIC LITERACY ♦ **Scientific literacy includes the ability** to read, write, discuss and present coherent ideas about science. ♦ **Scientific literacy also includes the** ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media. SCIENTIFIC NUMERACY ♦ **Scientific numeracy includes the** ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.	D INQ.1 Identify questions that can be answered through scientific investigation. D INQ.2 Read, interpret and examine the credibility and validity of scientific claims in different sources of information. D INQ.3 Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment. D INQ.4 Design and conduct appropriate types of scientific investigations to answer different questions. D INQ.5 Identify independent and dependent variables, including those that are kept constant and those used as controls. D INQ.6 Use appropriate tools and techniques to make observations and gather data. D INQ.7 Assess the reliability of the data that was generated in the investigation. D INQ.8 Use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms. D INQ.9 Articulate conclusions and explanations based on research data, and assess results based on the design of the investigation. D INQ.10 Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

CT Science Standards

This package meets some of the Grade School Science Standards of: 6.3a –

GLC#6 Earth's atmosphere (air) is a mixture of different amounts of gases (mainly nitrogen, followed by oxygen, carbon dioxide and water vapor). Air molecules constantly press on and around objects on Earth (air pressure). Due to the pulling force of Earth's gravity, air close to Earth is more dense than air higher in the atmosphere; denser air causes greater air pressure.

High School Standards

High School Physics	
Content Standards	**Supportive Concepts**
Motion and Forces Newton's laws predict the motion of most objects.	▪ When forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest. ▪ The law $F = ma$ is used to solve motion problems that involve constant forces. ▪ When one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction. ▪ Applying a force to an object perpendicular to the direction of its motion causes the object to change direction. ▪ Circular motion requires the application of a constant force directed toward the center of the circle. ▪ Newton's laws are not exact, but provide very good approximations unless an object is small enough that quantum effects become important.
Conservation of Energy and Momentum The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	▪ Kinetic energy can be calculated by using the formula $E = (1/2)mv^2$. ▪ Changes in gravitational potential energy near Earth can be calculated by using the formula (change in potential energy) = mgh. ▪ Momentum is calculated as the product mv. ▪ Momentum is a separately conserved quantity different from energy. ▪ An unbalanced force on an object produces a change in its momentum. ▪ The principles of conservation of momentum and energy can be used to solve problems involving elastic and inelastic collisions.
Heat and Thermodynamics Energy cannot be created or destroyed although, in many processes, energy is transferred to the environment as heat.	▪ Heat flow and work are two forms of energy transfer between systems. ▪ The work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature. ▪ The internal energy of an object includes the energy of random motion of the object's atoms and molecules. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object. ▪ Most processes tend to decrease the order of a system over time, so that energy levels eventually are distributed more uniformly.

Massachusetts Learning Standards

Earth and Space Science, GRADE 6-8

8. Recognize that gravity is a force that pulls all things on and near the earth toward the center of the earth. Gravity plays a major role in the formation of the planets, stars, and solar system and in determining their motions.

Physical Sciences

14. Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system.

16. Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium.

Technology/Engineering

2.3. Describe and explain the purpose of a given prototype.

2.4. Identify appropriate materials, tools, and machines needed to construct a prototype of a given engineering design.

Safety Standards

- Dry ice is very cold. Do not handle with bare hands, always use thermal gloves when handling.
- Always wear goggles when doing any experiment.
- When dropping objects there is a small chance the object could bounce onto a shoe, always wear closed toed shoes.
- Although these radiation sources are safe, always use gloves when handling the radiation sources.
- Review appropriate behavior expectations and cooperative peer or group work standards.
- Review the appropriate use of materials.
- Make any necessary individual student modifications.
- Monitor students to make sure they are following directions, handling materials with care and working cooperatively.

American Chemical Society –
Elementary School-
http://portal.acs.org/portal/PublicWebSite/about/governance/committees/chemicalsafety/publications/WPCP_012300

Middle and High School -
http://portal.acs.org/portal/PublicWebSite/about/governance/committees/chemicalsafety/publications/WPCP_012287
http://portal.acs.org/portal/PublicWebSite/education/policies/WPCP_010713

Council of State Science Supervisors;
http://www.csss-science.org/downloads/scisafe.pdf
Connecticut Department of Education–
http://www.csss-science.org/downloads/scisaf_cal.pdf
http://www.sde.ct.gov/sde/cwp/view.asp?a=2618&q=320896
http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/safety/middleschool_sciencesafety.pdf
http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/safety/science_safety.pdf

The Connecticut Science Supervisors Association – Science Safety White Paper –
http://cssaonline.net/cssapositionpapers.html

The activities included in this package do not contain anything of a highly toxic nature, but common sense indicates that nothing be put in the mouth.

Misconceptions and Facts

There are numerous misconceptions about space. An internet search on "Space Misconceptions" is the most effective way to browse through them. Here are just some that you may find.

http://homepage.mac.com/vtalsma/syllabi/2943/handouts/misconcept.html

http://www.aboutnuclear.org/view.cgi?fC=Space,Common_Concerns_and_Misconceptions

http://www.huntel.net/rsweetland/science/misconceptions/space.html

Discovery Center Activity

Living In Space

Content Covered

See above on page 4,5, and 6 for Science Standards.

Activity Summary

There is a short 10-15 minute introduction that includes some discussion and demonstrations in order to help the students get into the mindset of what they will be investigating in during their activity period.

Humans cannot live in space. Space is essentially a vacuum with temperatures that change instantly from exceptional high's to deep lows. In addition, as humans move farther away from a planet or moon, their body is less influenced by gravity. This has some detrimental short and long term effects on the human body. For a more complete description of what happens to the human body in space, you may want to look here:
http://www.esa.int/esaHS/ESAGO90VMOC_astronauts_0.html

Although space is very inhospitable place for people to live, scientists are always developing ways for humans to be protected and provided with the basic needs of life while in space.

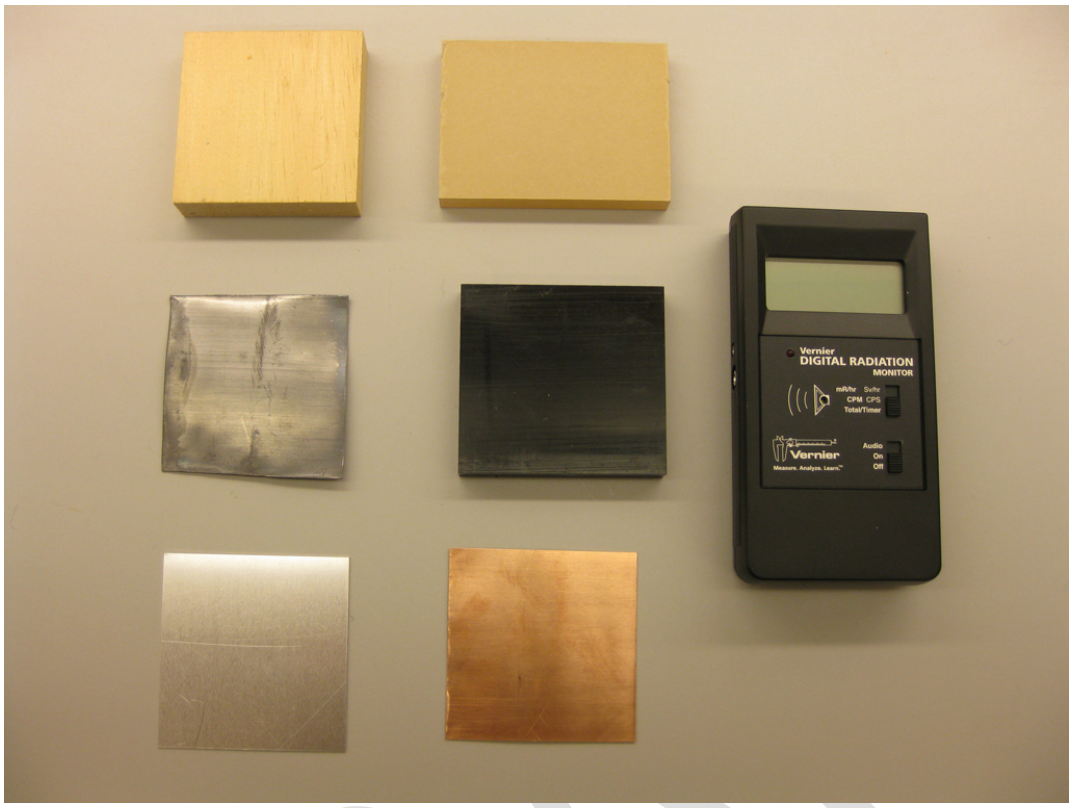
This activity is a collection of engineering problems based on technology that needs to be used in space in order for humans to survive. Each group chooses or is assigned a different location in outer space and each location has its own characteristics with respect to Radiation, Pressure, Temperature, and Gravity.

At the end of the program there will be a few minutes for each group to share their results with everyone else.

Materials

Radiation Station	Pressure Station
- Alpha, Beta, and Gamma Radiation Sources - Radiation Shield Set (aluminum, plastic, wood, copper, lead) - Vernier Radiation Counter - Shielded Gloves - Radiation Shield - Laptop	- Mini Bell Jar & Vacuum Pump - marshmallows - Toothpicks - Clay - Plastic Wrap - Paper - Pressure sensor
Temperature Station	**Gravity Station**
- Vernier Temperature Probe - Laptop - ¼ plastic tubing - Mini Circulator pump - Water - Dry Ice - Containers	- Vernier Force Sensor - Laptop - Objects to Drop - Cushion to stop object - Rope on a platform - Bicycle wheel

Radiation Materials:



Pressure Materials:

Activity

This activity is a collection of engineering problems based on technology that needs to be used in space in order for humans to survive. Each group chooses or is assigned a different location in outer space and each location has its own characteristics with respect to Radiation, Pressure, Temperature, and Gravity. They will also have the "safety range" for each of the 4 parameters. This range is a numerical goal that they need to force their parameters into. As the students go from station to station, they need to figure out what is required to survive in their group location. Since each location is different, then each result will be slightly different. For example, if one group is close to the sun, and another is far away from the sun, the insulation used will be different between the two groups, or the radiation is different in each location then the absorbing material can be different.

There are no formal instructions for each station as the goal of this program is to allow the students to experiment with what they have to accomplish the goal.

Teacher Notes:

Radiation:

Alpha radiation is the easiest to block, it can be blocked with a piece of paper or plastic. Beta is also easy to block, it can be blocked with plastic or metal. Gamma is the hardest to block as it can only be blocked by lead.

Pressure:

In designing a pressure suit, it needs to be able to withstand the internal pressure of the person (marshmallow) and the captured air so that it will not explode in a vacuum, or get crushed when the pressure increases again.

Temperature:

It is important that the human's body stays at a somewhat constant comfortable temperature. This can be accomplished through passive means (insulation) in combination with active technology (flowing fluids). Both are available for students to experiment with.

Gravity:

As humans desire to stay out longer in space, means of generating a force like gravity need to be engineered. The conventional way is to have something that is spinning with the living areas on the inside outer edge of the circle. The centripetal force generated mimics gravitational forces on earth. The students can experiment with a few different ways to accomplish this.

Sharing/Discussion

At the end of the program there will be a few minutes for each group to share their results with everyone else.

Teacher Trail Guides

Putting Science to Work – Aerospace
Pioneer Aerospace

Trail Guide Pioneer Aerospace: 5th Floor North

Exploring Space Gallery -

Watch Pioneer Aerospace – Parachutes-Putting Science to Work Video (right video)

When you design parachutes for spacecraft, what is very important to understand?

How is Mars atmosphere compared to the Earth's?

Teacher Notes:

When designing parachutes or anything that goes in an alien atmosphere it is important to have an understanding of what type of atmosphere it is. For example the atmosphere on Mars is 1/1000 of that on Earth, so it is very thin. On a plant like Jupiter it would be much greater than the atmosphere on Earth.

Trail Guide Pioneer Aerospace: 5th Floor North

Exploring Space Gallery -

Watch Pioneer Aerospace – Parachutes-Putting Science to Work Video (right video)

Why do they do so much testing on parachutes for space craft?

What kinds of things do they test?

Why are parachutes important for spacecraft?

Teacher Notes:

Because these parachutes are millions of miles away from any human, it needs to work 100% of the time. If the chute does not work, there is no point in going to the planet. So it is very important to test the construction of the parachute thoroughly so that all of the bugs are worked out.

Trail Guide Pioneer Aerospace: 5th Floor North

Exploring Space Gallery -

Watch Pioneer Aerospace – Parachutes-Putting Science to Work Video (right video)

What kind of education to do you need to work in this type of field?

Will this field be growing in the future? What are some of the benefits and drawbacks of this type of career?

Teacher Notes:

All engineering jobs typically require a college degree in some type of engineering. There are many different types of engineering one can choose to focus on in college. Engineers typically are good with problem solving, creative thinking, mathematics, computers, and good with their hands. They pay is very good and since our world today is highly technology based, the demand for engineers is sure to rise.

Student Trail Guides

Putting Science to Work – Aerospace
Pioneer Aerospace

Trail Guide Pioneer Aerospace: 5th Floor North

Exploring Space Gallery -

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What kind of education to do you need to work in this type of field?

Will this field be growing in the future? What are some of the benefits and drawbacks of this type of career?

Safety Disclaimer:

The content of this Teacher's Resource section is intended to serve as an educational resource for teachers and students.

Preparing for the safety of yourself and your students is a critical step in planning for any hands-on science- related activities. Prior to conducting any of the activities included in this resource section, please familiarize yourself and your students with any potential hazards, and take the necessary precautions appropriate for each specific activity.

Connecticut Science Center is not responsible for the contents of any books, videos, websites or other resources to which we provide a reference and does not necessarily endorse the opinions, activities, services, products or information expressed within them.

Professional Development Opportunities

Introduction to Inquiry Professional Development Workshop

The Connecticut Science Center's Introduction to Inquiry Professional Development workshop was launched in the summer of 2005 and funded by the GE Education Foundation. Based upon the Exploratorium's Institute for Inquiry in San Francisco, our Science Center's professional development workshop is a five day immersion experience in inquiry-based learning and teaching plus an additional two days at the Annual Follow-Up Conference.

The Center's Introduction to Inquiry workshop is tied directly to the CT Science Framework Connecticut adopted in 2004. The workshop's programming addresses requirements in Connecticut's Common Core of Teaching and Common Core of Learning as well.

Classroom Application

This five-day workshop will focus on classroom strategies for implementing inquiry-based experiences.**Only participants who have previously attended the Introduction to Inquiry workshop are eligible to attend this workshop.**

Formative Assessment workshop

This five-day workshop will focus on additional classroom strategies for implementing inquiry-based experiences, as well as formative assessment strategies to be used in the science classroom. **Only teams who have previous attended the Introduction to Inquiry and Classroom Applications are eligible to attend this workshop.**

For more information please visit:
http://www.ctsciencecenter.org/educate/institute-for-inquiry-workshop.aspx

Teacher Websites

University of Colorado at Boulder – Interactive Simulations
http://phet.colorado.edu/
This website contains many interactive computer simulations too numerous to mention here.

PBS Website on living in the space station
http://www.pbs.org/spacestation/station/living.htm

Discovery Website on living in the space station
http://school.discoveryeducation.com/schooladventures/spacestation/

How stuff works on living in space
http://science.howstuffworks.com/space-station4.htm

Videos

NASA astronauts comparing living in space to living on earth
http://www.redorbit.com/news/video/education/9/living_conditions_in_space/25097/index.html

Classroom Materials

http://www.teachersource.com/AirPressure/MicroscaleScience/MicroscaleVacuumApparatus.aspx

http://www.flinnsci.com/store/Scripts/prodView.asp?idProduct=16558

Software

University of Colorado at Boulder – Interactive Simulations

http://phet.colorado.edu/

This website contains many interactive computer simulations too numerous to mention here.

Career Information

http://careers.stateuniversity.com/pages/381/Aerospace-Engineer.html

Student Resources

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Connecticut Science Center is not responsible for the contents of any books, videos, websites or other resources to which we provide a reference and does not necessarily endorse the opinions, activities, services, products or information expressed within them.

Websites:

University of Colorado at Boulder – Interactive Simulations
http://phet.colorado.edu/en/simulations/category/physics
This website contains many interactive computer simulations too numerous to mention here.