COOL SUITS

Activity topic selected from NASA's 21st Century Explorer newsbreak "How will your imagination help you become an explorer?"

Educator Section

Grade Level: 3-5

Connections to Curriculum: Science

Basic Science Process Skills: observing, predicting, measuring, classifying, communicating (American Association for the Advancement of Science)

Teacher Preparation Time: 30 minutes

Lesson Duration: 90 minutes

Prerequisite: heat, light, reflection, absorption, solar energy

National Education Standards addressed in this activity include Science, Mathematics, and Health. For an alignment to standards in this activity, see page 5.

Introduction

Astronauts depend upon their space suits to hold in air needed for breathing as well as pressure to keep them alive in the near vacuum of space. Space suits also help keep astronauts at a comfortable temperature; neither too hot nor too cold. For this reason, space suits are made from materials and colors that reflect large amounts of energy. By avoiding the absorption of energy, the astronauts are kept at a comfortable temperature for longer periods of time.

Lesson Objective

In this lesson, students will test and make an analysis of the relationship between reflection/absorption and color.

Problem

Which color, black or white, reflects energy better? Which color absorbs energy better?

Learning Objectives

The students will

- collect data by measuring temperature in 2 different colored envelopes (black and white).
- use data to infer which color, black or white, reflects energy better and which color absorbs energy better.

Materials

- NASA's 21st Century Explorer 30-second newsbreak, "How will your imagination help you become an explorer?" (Download the newsbreak at http://education.jsc.nasa.gov/explorers.)
- 1 thermometer to serve as the control for the entire class (calibrated in units of 1-2 degrees Celsius)
- ruler or measuring tape

Per group

- 2 construction paper envelopes (See Pre-lesson Instructions.)
    - 1 sheet (8.5" x 11") of black construction paper
    - 1 sheet (8.5" x 11") of white construction paper
    - tape, staples or glue to fasten
- 2 thermometers (calibrated in units of 1-2 degrees Celsius)

Materials Required

thermometers

black construction paper

white construction paper

stapler

tape or glue

ruler or measuring tape

small boxes (shoe box sized)

stopwatches

marker

window, lamp, or other light source

NASA's 21st Century Explorer 30-second newsbreak – "How will your imagination help you become an explorer?"

- window, lamp, or other light source such as an overhead projector
- 1 small box (shoe box, lid not needed)
- stopwatch, or timepiece with a second hand (watch or clock)

Per student

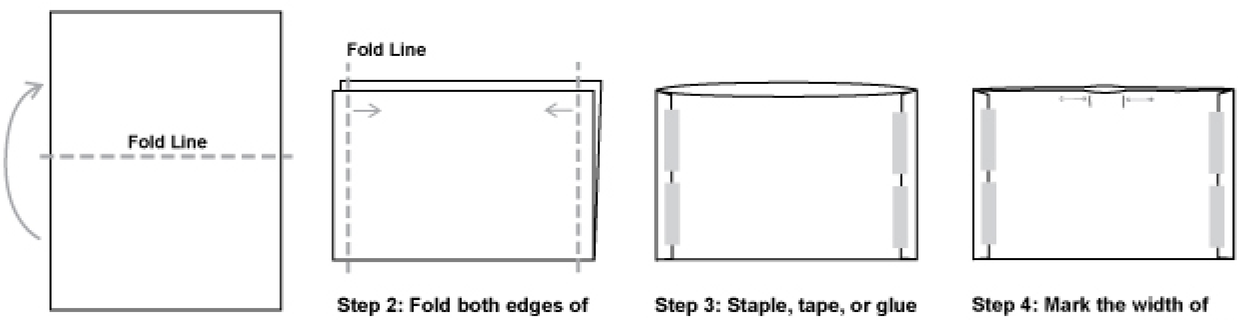
- Cool Suits Student Section

Safety

Remind students about the importance of classroom rules and lab safety rules. Caution students about the proper use of thermometers.

Pre-lesson Instructions

- Students should work in groups of 2 or 3.
- Locate a sunny area such as a windowsill, or a sunny outside location for the “test site”. If a sunny location is not available, a lamp or other light source may be used.
- Each group will need 2 small envelopes: one made out of black construction paper, and the other made out of white construction paper. To save time, the envelopes may be made prior to class. (See diagram.)
- Using the ruler, measure the width of the thermometer. Use this measurement to mark the width of the thermometer on the open part of the envelope using a marker. Place a staple along each side of the measured line (See Step 4). The staples should be placed close enough so that when the thermometer is placed in the opening, it will stand.



Step 1: Fold paper in half.

Step 2: Fold both edges of paper together towards the middle to form a pocket.

Step 3: Staple, tape, or glue the sides to seal and form an envelope.

Step 4: Mark the width of the thermometer and staple beside each line.

Lesson Development

To prepare for this activity, the following background information is recommended:

- Read NASA’s 21st Century Explorer Web Text Explanation titled “How will your imagination help you become an explorer?” at http://education.jsc.nasa.gov/explorers.
- Read the following text taken from the Observation Section of the Cool Suits Student Section.

Observation

Living and working in space is challenging. Outside the spacecraft, astronauts depend upon their space suits to hold in air needed for breathing as well as pressure to keep them alive in the near vacuum of space.

Space suits also help keep astronauts at a comfortable temperature; neither too hot nor too cold. In the harsh environment of space, temperature can vary greatly from the extreme heat of the Sun (solar energy) to the extreme coldness of the darkness of space. For this reason, space suits are made from different colors and materials that reflect large amounts of energy. By avoiding the absorption of energy, the astronauts are kept comfortable for longer periods of time.

In this activity you will test 2 different colors (black and white) to see if color affects energy reflection and absorption.

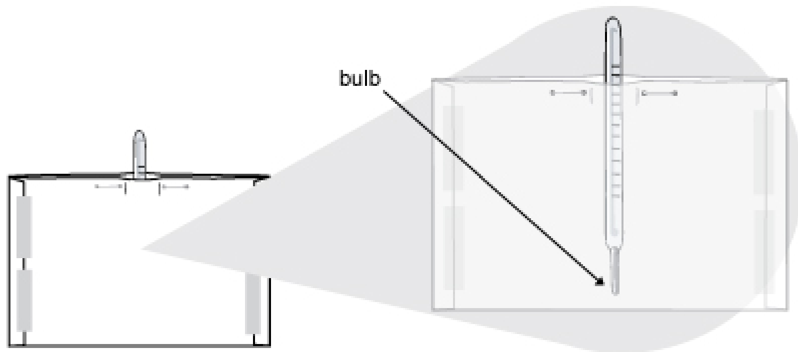
- If needed, additional research can be done on the following science topics:
  - solar energy
  - heat
  - light
  - reflection
  - absorption

Instructional Procedure

1. Throughout this lesson, emphasize the steps involved in the scientific method. These steps are identified in ***bold italic*** print throughout the Instructional Procedure Section and in **bold** print throughout the Cool Suits Student Section.
2. Preview the Scientific Investigation Rubric with the students, highlighting each Performance Indicator.
3. Show NASA's 21st Century Explorer newsbreak "How will your imagination help you become an explorer?" to engage students and increase student knowledge about this topic.
4. Remind students about solar energy, energy in the form of heat and light, and reflection and absorption.
5. Review the problem with the students.
   Problem: Which color reflects energy better? Which color absorbs energy better?
6. Have the students read the ***Observation*** Section in the Cool Suits Student Section and discuss in their groups.
7. As a class, have students identify the colors and materials of the clothes they are wearing. List common characteristics, such as similar colors, similar materials, etc. Discuss whether the colors and materials they chose to wear are affected by the season. How will their choices change when the seasons change?
8. Encourage your students to discuss and make ***observations*** about this topic by completing the first two columns in the KWL (KNOW/WANT TO KNOW/LEARNED) chart on the Cool Suits Student Section. Use the KWL chart to help students organize prior knowledge, identify interests, and make real-world connections. As students suggest information for the "KNOW" column, ask them to share how they have come to know this information.
9. Ask your students if they have predictions relating to this experiment and the "problem question". Help them refine their predictions into a ***hypothesis***. In their Student Section, they should restate the "problem question" as a statement based upon their observations and predictions. Encourage students to share their hypothesis with their group.
10. Students will ***test*** their hypothesis following this procedure.
    (The following steps are taken from the Student Section. Educator specific comments are in italics.)

    Place one thermometer without an envelope at the "test site" to act as a control. For this experiment, the "test site" will be a sunny area such as a windowsill, or an outside sunny location. A lamp or overhead projector can be used as an alternate source of light.

1. Put both envelopes inside a small box to hold them upright while you are working with them.
2. Carefully place a thermometer inside each envelope. The staples should hold the thermometers upright in the envelopes. See the diagram below.



3. Let the thermometers rest in the envelope for at least 10 minutes to record the temperature of the new environment. Then check the temperature in degrees Celsius. Record this data at 0 minutes in the Cool Suits Data Sheet. Also, record the temperature from the control thermometer, which your teacher will have.

   Let the students know where the "control" thermometer is placed, and announce the temperature for them to record in the 0 minutes column of the Cool Suits Data Sheet.

4. Take each envelope from the box and place them in the "test site" (windowsill or outside) where they will receive direct sunlight. Make sure that both envelopes receive the same amount of sunlight.
5. Predict how many degrees the temperature will change in each envelope over the 5-minute period. Record the predicted temperatures on the Cool Suits Data Sheet. Discuss your predictions with your group.

   Introduce "elapsed time" to students using the National Mathematics Education Standards (see page 5).

6. After 5 minutes, ***collect and record data*** by reading and recording the temperature of the thermometers on the Cool Suits Data Sheet. Discuss the data with your group.
7. Every 5 minutes for the next 30 minutes, repeat steps 5 and 6.

   Re-introduce and reinforce the concept of elapsed time.

   Continue to record temperature changes using elapsed time and thermometers, predicting before each temperature reading.

Study Data

After taking all measurements, students should study the data on the Cool Suits Data Sheet by answering the questions on the Cool Suits Student Section.

Conclusion

- Discuss the answers to the Cool Suits Student Section questions.
- Have the students update the LEARNED column in their KWL chart.
- Have students write a conclusion by restating their hypothesis and explaining how the results do, or do not, support their hypothesis.

- Ask students to compare their individual data to the class data. What patterns can be found?
- Ask students how their findings relate to the development of new space suits for space exploration.
- Ask students what they wonder now. Encourage students to design their own activities.

Assessment

- Assess student knowledge through questioning.
- Observe and assess student performance throughout the activity using the attached Scientific Investigation Rubric.

Activity Alignment to National Education Standards

National Science Education Standards

Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry (K-8)
- Understandings about scientific inquiry (K-8)

Content Standard B: Physical Science Standards

- Properties and changes of properties in matter (5-8)
- Transfer of energy (5-8)

Content Standard E: Science and Technology

- Abilities of technological design (K-8)

Content Standard F: Science in Personal and Social Perspectives

- Changes in environments (K-4)

National Mathematics Education Standards

Data Analysis and Probability Standard:

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
  - collect data using observations, surveys, and experiments
- Develop and evaluate inferences and predictions that are based on data
  - propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions and predictions

National Health Education Standards

Standard 4: Students will analyze the influence of culture, media technology and other factors on health.

- Describe ways technology can influence personal health (K-4)

Curriculum Explorations

To extend the concepts in this activity, the following explorations can be conducted:

Mathematics

Create a line graph to show the change in temperature of each envelope. Predict what the line graph would look like if you kept the thermometers in the sunlight for another 20 minutes. Predict what the line graph would look like as the Sun sets.

National Mathematics Education Standards

Algebra Standard:

- Understand patterns, relations, and functions

    - represent and analyze patterns and functions, using words, tables, and graphs

Data Analysis and Probability Standard:

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
    - collect data using observations, surveys, and experiments
    - represent data using tables and graphs such as line plots, bar graphs, and line graphs
- Develop and evaluate inferences and predictions that are based on data
    - propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions

Language Arts

Ask students to explain the experiment. How might students improve this experiment? Where might there have been mistakes made? How might these mistakes have affected the results?

National English Language Arts Education Standards

- 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, people) to communicate their discoveries in ways that suit their purpose and audience.

Engineering and Design

Try the activity again with “insulators” such as cotton balls or tissue paper. Other examples may include: sand, Styrofoam, or plastic.

Try the activity again with material other than construction paper. For example: aluminum foil, glass or plastic.

Challenge the students to design and create a “space suit” that will maintain a steady temperature in extreme hot and cold temperatures. Students will be given an empty paper towel tube and asked to design the tube so that the temperature will not vary more than 5 degrees Celsius when it is put in sunlight and then in the freezer.

National Science Education Standards

Content Standard E: Science and Technology

- Abilities of technological design (K-8)

Sources and Career Links

Thanks to subject matter experts Sharon Garrison and Heather Paul for their contributions to the development of this education material.

Find out more about Sharon Garrison and her work at the NASA Institute for Advanced Concepts (NIAC) at the Goddard Space Flight Center: http://www.niac.usra.edu.

Heather Paul is a project engineer for the Advanced Extravehicular Activity (AEVA) team at the NASA Johnson Space Center, working on the designs for the next generation space suits that astronauts will wear on the moon and Mars. To find out more about her visit: http://quest.arc.nasa.gov/people/bios/space/paulh.html and http://profiles.jsc.nasa.gov.

This activity was adapted from NASA educational products.
Lesson development by the NASA Johnson Space Center Human Research Program Education Outreach team.

Scientific Investigation Rubric

Activity: COOL SUITS

Student Name ____________________________________ Date ____________________

Performance Indicator	0	1	2	3	4
The student developed a clear and complete hypothesis.					
The student followed all lab safety rules and directions.					
The student followed the scientific method.					
The student recorded all data on the data sheet and drew a conclusion based on the data.					
The student asked engaging questions related to the study.					
The student described at least one recommendation for NASA in the area of space suit design.					
Point Total					

Point total from above: __________ / (24 possible)

Grade for this investigation __________________

Grading Scale:

A = 22 - 24 points

B = 19 - 21 points

C = 16 - 18 points

D = 13 - 15 points

F = 0 - 12 points