

## Science Modules

**This module focuses on the relationship between basic physical science concepts about heat and the challenges faced by the engineers designing the Genesis spacecraft.** If you are using Genesis science modules for the first time, read the [User's Guide](#) thoroughly before you begin. ([View User's Guide as PDF.](#))

The following classroom materials are available in Portable Document Format (PDF) for your browsing and printing convenience. The files are print-optimized, and should be printed to achieve maximum resolution. **Adobe's new Acrobat Reader 4.0 is required** to view and/or print. To install the FREE reader, visit the [Adobe Web site](#).

Take a look at additional [science modules](#) that are available on the Genesis Web site. All technical terms in the science modules are compiled in the [Glossary](#) for easy access.

[Technology Applications](#) are available for this module.



### Heat: An Agent of Change

This module focuses on the relationship between basic physical science concepts about heat and the challenges faced by the engineers designing the Genesis spacecraft. Controlling the movement of heat to prevent unwanted changes in materials requires basic understandings about thermodynamics.

#### The Invisible Power of Heat

- [Student Text](#)

 [PowerPoint Presentation](#)

 [PowerPoint as PDF](#)

#### Briefing

Use the text material [The Invisible Power of Heat](#) to create student interest in learning more about thermodynamics. The text starts with students reading the myth of Daedalus and Icarus, emphasizing their technological challenge. It then draws a parallel with the challenge of designing the Genesis spacecraft to prevent damage caused by heat.



## What We Know About Heat

- [Teacher Guide](#)
- [Student Activity](#)

## Atoms and Molecules in Motion

- [Teacher Guide](#)
- [Student Activity](#)

## Expansion and Contraction

- [Teacher Guide](#)
- [Student Activity](#)

## Thermometers and Thermostats

- [Teacher Guide](#)
- [Student Activity](#)

## Heat Effects on Metals

- [Teacher Guide](#)
- [Student Activity](#)

## Exploration

Use the activity, “What We Know About Heat” to generate discussion, leading students to examine some of their basic assumptions. This activity offers the teacher a snapshot of the class’s present level of understanding and background knowledge.

A series of activities follows. It is up to the discretion of the teacher to determine which activities are useful as review or as initial instruction about certain underlying concepts. The activities described in this module include:

- “Atoms and Molecules in Motion”--a simulation activity that demonstrates the concept of heat as energy of molecular motion.
- “Expansion and Contraction”--a series of teacher demonstrations and short activities investigating how materials expand when heat is added.
- “Thermometers and Thermostats”--a series of teacher demonstrations and short activities showing the basic procedures for using a thermometer and how a thermostat works.
- “Heat Effects on Metals”--a more advanced activity dealing with the heat capacity of metals.

## Student Mission

Students will be able to apply information they learn about heat, how heat moves through materials, what effect this movement has on those materials, and how this movement can be controlled. They will design a structure that prevents heat movement.

## Three Methods of Heat Transfer

- [Teacher Guide](#)
- [Student Activity](#)

## Heat & Thermodynamics

- [Student Text](#)

## Activities with Insulators & Conductors

- [Teacher Guide](#)
- [Student Activity](#)

## Insulators and Conductors: The Coefficient of Conductivity

- [Student Text](#)

## Heat Shields as Insulators

- [Student Text](#)

## Development

During this more formal encounter, the students conduct experiments, make observations, and read and discuss text. The student must record data, conduct analyses, and interpret relationships between evidence and decision making. Teachers may introduce technical scientific vocabulary here.

Use the activities in “Three Methods of Heat Transfer “ to review or teach conduction, convection, and radiation, and to review the laws of thermodynamics. An optional student text, “Heat and Thermodynamics,” introduces basic concepts of heat transfer, and includes discussion of the three laws of thermodynamics

Students further explore the thermal properties of various materials in the series, “Activities with Insulators and Conductors.” They then read “Insulators and Conductors: The Coefficient of Conductivity.”

The student text, “Heat Shields as Insulators“ introduces the concept of thermal protection from frictional heating.

## Curriculum Connections

### National Standards Addressed

#### Grades 5-8

##### *Science as Inquiry*

- Understandings about scientific inquiry
- Abilities necessary to do scientific inquiry

##### *Physical Science*

- Properties and changes of properties in matter
- Transfer of Energy

##### *Science and Technology*

- Understandings about Science and Technology
- Abilities of technological design

##### *Science in Personal and Social Perspectives*

- Risks and benefits
- Science and technology in society

##### *History and Nature of Science*

- Nature of Science

#### Grades 9-12

##### *Science as Inquiry*

- Understandings about scientific inquiry
- Abilities necessary to do scientific inquiry

##### *Physical Science*

- Conservation of energy and the increase in disorder
- Interactions of Energy and Matter

##### *Science in Personal and Social Perspectives*

- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

##### *Science and Technology*

- Understandings about Science and Technology
- Abilities of technological design

##### *History and Nature of Science*

- Science as a Human Endeavor
- Nature of Scientific Knowledge
- Historical Perspectives



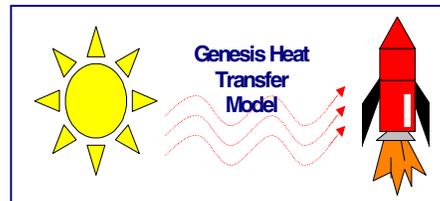
### Protecting the Genesis Spacecraft from Heat

- [Teacher Guide](#)
- [Student Activity](#)

### Interaction/Synthesis

Students interact with peers in order to accomplish many of the tasks in the sections above. However, in the activity, “Protecting the Genesis Spacecraft from Heat,” synthesis is thoroughly accomplished through using prior learning to create something new and different

In “Protecting the Genesis Spacecraft from Heat,” students evaluate the effectiveness of insulating materials in the design of the spacecraft. Students will build a heat transfer model from which they draw conclusions through observation and experimentation.



### Survival!

- [Teacher Guide](#)
- [Student Activity](#)

### Assessment

The final activity, “Survival!” assesses students’ abilities to make and justify decisions, test and modify designs, select mediums of communication for specified audiences, and craft and deliver those messages.

In “Survival!” students design a method for communicating to an appropriate audience an accurate description of their product, the results of their tests of its efficiency, and their conclusions about its usefulness.



This education module, *Heat: An Agent of Change* was developed by educators at [Mid-continent Research for Education and Learning](#).



Writers: Greg Rawls, McREL  
Marty Henry, McREL  
Alice Krueger, McREL

Contributing Writers:  
Carla Jacobs, Coleman Middle School, Wichita, KS  
Matt Kuhn, Littleton Academy, Littleton, CO

Graphics created by:  
Judy Schlecte, McREL

Layout: Amy Hoza, McREL

Technical Editor: Jacinta Behne, McREL

Special Thanks to the following Reviewers:  
Dr. Gil Yanow, Jet Propulsion Laboratory  
Dr. Virgil Mireles, Jet Propulsion Laboratory  
Dr. Donna Bogner