

Ice Cube Race

Student Objectives

The student:

- will explain several methods of transferring energy
- will explain what is meant by the second law of thermodynamics.

Materials (per group):

- small block of ice–5 oz (150 mL) water frozen in a paper cup, then removed
- plastic bag with zip seal
- graduated cylinder
- Science Journal

Key Words:

change of state
conduction
convection
energy source
energy transfer
friction
kinetic energy
physical change
potential energy
radiant energy
thermal energy

Time:

1 class period

Background Information

There are several forms of energy, subdivided into two categories–kinetic and potential.

Kinetic Energy

- Electrical Energy
- Radiant Energy (i.e. electromagnetic radiation)
- Thermal Energy
- Motion Energy
- Sound

Potential Energy

- Chemical Energy
- Stored Mechanical Energy (i.e. a spring)
- Nuclear Energy
- Gravitational Energy

By this time, students should know several facts about energy transfer.

- When warmer objects are put with cooler ones (at a distance or next to each other), the warmer objects transfer internal energy (emitted as heat) to the cooler ones until they all reach the same temperature.
- Things that give off heat can also give off other sorts of energy, including light.
- Heat is produced any time one thing rubs against something else, and by mechanical and electrical machines.
- Some materials transmit heat energy much better than others. Materials, called insulators, are poor conductors and can reduce the transmission of heat from one object to another.

Further investigations should help middle-school students learn the following four points about energy transformation:

- Energy and matter cannot be created or destroyed; they can only be transformed each into each other.
- 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.
- Heat can be transferred through materials by the collisions of atoms or across space by radiation.
- Energy appears in different forms. Heat energy is in the disorderly motion of molecules; chemical energy is in the arrangement of atoms; mechanical energy is in moving bodies or in elastically distorted shapes; gravitational energy is in the separation of mutually attracting masses.

At this early stage, there may be some confusion in students' minds between energy and energy sources. Focusing on energy transformations will help them to understand the difference. Food, gasoline, and batteries obviously get used up. But the energy they contain does not disappear; it is changed into other forms of energy through physical or chemical processes.

Procedure

1. Divide class into groups of two.
2. Explain the procedure to the class:
 - Each group will place an ice cube, made from 5 oz (150 mL), in a plastic bag.
 - They will have five minutes to transfer as much energy as they can to their cube (to melt it). They may place the plastic bag anywhere they want or do anything to it, as long as the bag remains sealed.
 - At the end of five minutes, each group will measure the amount of water in their bag using a graduated cylinder.
3. Pass out materials and begin timing.
4. Help students as needed during the five minute interval.
5. After students measure their water, lead a discussion on which methods produced the most water, emphasizing what type of energy transfer is occurring in each case.
6. Students should complete their Science Journal.

Key Words & Definitions

- **change of state** – a physical change that occurs when matter changes to another state (for example liquid water to steam)
- **conduction** – the transmission of heat across matter
- **convection** – heat transfer in a gas or liquid by the circulation of currents from one region to another
- **energy source** – object or material that produces energy by changing it from one source to another
- **energy transfer** – a change of energy from one form to another

- **friction** – a force that opposes the relative motion of two material surfaces in contact with one another
- **kinetic energy** – the energy possessed by an object because of its motion
- **physical change** – a change in matter from one form to another, without forming new substances
- **potential energy** – the energy of a particle or system of particles derived from its position, or condition, rather than motion. For example: a raised weight, coiled spring, or charged battery.
- **radiant energy** – energy that is transmitted in the form of electromagnetic radiation (i.e. solar), is energy that exists in the absence of matter, and that can travel through space
- **thermal energy** – the kinetic energy of the motion and vibrations of microscopic particles such as molecules and atoms. Thermal energy is quantified by temperature.

Related Research

1. Have the students do a second trial using what they learned from the first trial. Graph the results of both trials to see the class improvement.
2. Write the different types of energy on the board. Have the students design another version of the experiment that uses only one form of energy (one they haven't tried before) to melt the ice. Graph the results by energy form on the board to find out which was most successful. Have the students critique the other experiments.
 - Were the groups using only the form of energy that they claimed, or were there other forms involved also?
 - How could they use this form of energy differently to obtain better results?
 - Is it possible to do an energy transfer without having some thermal energy involved also?

Related Reading

- *Exploring Energy With Toys: Complete Lessons for Grades 4 - 8* by Beverley A.P. Taylor (McGraw-Hill, 1997)
Classroom-tested projects using toys illustrate basic concepts of physical science. Topics include the energy of motion, stored energy, energy conservation, and more.

Internet Sites

<http://www.learner.org/exhibits/parkphysics/>

An Annenberg/CPB site, Amusement Park Physics, with information on the forces behind amusement park rides. Includes interactive roller coaster building, predicting the outcome of bumper car crashes, and a weightless water 'trick'.

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Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6	.7	.8	.9	.10	.11	.12
Grade 6														
Practice of Science	# 1	SC.6.N.1				X								
Grade 7														
Energy Transfer & Transformations	# 11	SC.7.P.11	X	X										
Language Arts Standards	Sixth Grade: LAFS.6.SL.1.1 Seventh Grade: LAFS.7.SL.1.1 Eighth Grade: LAFS.8.SL.1.1													

Sixth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.6.N.1.4 - Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.

Language Arts–Standards for Speaking & Listening

- LAFS.6.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 6 topics, texts, and issues, building on others’ ideas and expressing their own clearly.

Seventh Grade Benchmarks

Science–Big Idea 11: Energy Transfer and Transformations

- SC.7.P.11.1 - Recognize that adding heat to or removing heat from a system may result in a temperature change and possibly a change of state.
- SC.7.P.11.2 - Investigate and describe the transformation of energy from one form to another.

Language Arts–Standards for Speaking & Listening

- LAFS.7.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 7 topics, texts, and issues, building on others’ ideas and expressing their own clearly.

Eighth Grade Benchmarks

Language Arts–Standards for Speaking & Listening

- LAFS.8.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 8 topics, texts, and issues, building on others; ideas and expressing their own clearly.

National Next Generation Science Standards - Sixth to Eighth Grade Standards

Science–Energy

- MS-PS3-3 - Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- MS-PS3-4 - Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

Ice Cube Race

1. How much water did you have at the end of five minutes?
2. What did you do to your plastic bag to help melt the ice?
3. What type of energy (s) did you use?
4. In your class, what method seemed to melt the ice the best?