CRISP Kit Teacher Module

Title of Module:

Exploring Properties: Heat Transfer

Grade Level(s):

5+

Subject(s) or Unit of Study:

Conductivity, Energy, Properties of Materials

Est. Length of Activity:

N/A

Student Objectives:

Students will learn:

- Thermal conductivity can be higher or lower for different materials
- The way a material behaves on the macro scale depends on its nanoscale structure

Vocabulary:

Thermal conductivity, Graphene, Graphite

Materials:

- Black aluminum block
- Black high-density foam block
- 2 black o-rings
- Pyrolytic graphite piece
- Sponge
- Insulated bag
- “Thermal conductivity of Graphene” page (NanoDays)

ICE NOT PROVIDED

Learner Background:

Graphene is a one-atom-thick layer of carbon atoms arranged in a hexagonal lattice (honeycomb pattern). One atom thick is only a fraction of a nanometer - which is a **billionth of a meter** - that’s the thinnest material known to man. Graphene is also incredibly strong - about 200 times stronger than steel, and an excellent conductor of heat and electricity. Graphite, which is commonly found in pencil lead, is made up of graphene. Graphene has a very high thermal conductivity, it carries heat better than any other material – even better than silver or copper which are excellent heat conductors.

Learning Activity or Procedure:

1. Have students feel each of the black blocks. Discuss their observations
2. Have the students predict which block will melt the ice faster
3. Place the O-ring on the blocks (optional) and place a piece of ice on each block.
4. You can have the students time the event, and determine the rate of the reaction
5. Once ice is melted, dry the blocks and have the students feel them again.
6. Discuss their observations

1. Place a piece of ice on one of the black blocks
2. Have students feel the graphite piece and predict what will happen when they touch it to the ice
3. Have students put the thin edge of the graphite to the ice (to cut the ice)
4. Discuss their observations

Assessment:

See last page for student worksheet

Additional Resources:

http://www.explainthatstuff.com/graphene.html

Teacher Notes:

- The provided insulated bag will help to keep the ice cool during the activity for at least a few hours, but may need to be emptied and refilled if the ice begins to melt.
- The O-rings are meant to contain the water on the block after the ice is melted. They may be omitted from the activity if you wish.

Safety:

N/A

STEM Careers:

Materials Scientist
Researcher
Engineer
Environmental Engineer
Solar Energy Systems Engineers
Nano-technologist
Aerospace Engineers
Computer Hardware Engineers
Materials Engineers
Mechatronics Engineers
Nanosystems Engineers
Nanotechnology Engineering Technologists
Nanotechnology Engineering Technicians

Standards:

Next Generation Science Standards:

NGSS Performance Tasks	**HS-PS3-2** • Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
NGSS - (DCI) Disciplinary Core Ideas	**PS3.A: Definitions of Energy** • Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
NGSS - (CC) Cross-Cutting Concepts	**CC-3 Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. **CC-5 Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.
NGSS - (SEP) Science and Engineering Practices	**SEP 2 – Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Student Worksheet

Activity 1

You have a black aluminum block and a black high-density foam block.

1. Please describe the blocks and your observations (look, feel etc.)

2. Which block do you think will cause the ice to melt fastest? Why?

Place the O-rings on the black blocks and put a piece of ice in the center of each. *your teacher may ask you to time and record the time it takes for the ice to melt on each block*

3. Which block melted the ice the fastest? Why do you think this material conducted heat faster than the other?

Dry off the blocks and feel them again.

4. Describe your observations and compare them to the beginning of this activity

Place an ice cube on one of the blocks. Now you will be working with a piece of graphite.

5. Describe your observations of the piece of graphite. Predict what will happen if you touch the edge of the graphite to the ice cube (and why)

Touch the edge (or corner) of the graphite to the ice.

6. What happened when the graphite touched the ice? Why do you think this happened?

Activity 1

You have a black aluminum block and a black high-density foam block.

1. Please describe the blocks and your observations (look, feel etc.)

The foam block feels warmer than the aluminum

2. Predict which block do you think will cause the ice to melt fastest? Why?

Place the O-rings on the black blocks and put a piece of ice in the center of each. *your teacher may ask you to time and record the time it takes for the ice to melt on each block*

3. Which block melted the ice the fastest? Why do you think this material conducted heat faster than the other?

The aluminum block melts the ice much faster than the high-density foam block. The aluminum is a very good conductor of heat and the foam is not. When you touch the aluminum block, the heat quickly transfers from your hand into the block. But when you touch the foam block only a little heat (slowly) transfers from your hand into the block. This is why your hand still feels warm where the aluminum block made your hand feel cold. Remember both blocks are at room temperature which is much warmer than an ice cube.

The ice melted slowly on the high-density foam block because the heat from the foam block transferred to the ice very slowly; the heat from the aluminum block however, transferred quickly to the ice cube, causing it to melt very quickly.

The difference happens because of thermal conductivity. Thermal conductivity measures how quickly heat flows through a material. The aluminum has a higher thermal conductivity and the foam has a lower thermal conductivity

Dry off the blocks and feel them again.

4. Describe your observations and compare them to the beginning of this activity

Place an ice cube on one of the blocks. Now you will be working with a piece of graphite.

1. Describe your observations of the piece of graphite. Predict what will happen if you touch the edge of the graphite to the ice cube (and why)

Touch the edge (or corner) of the graphite to the ice.

2. What happened when the graphite touched the ice? Why do you think this happened?

Graphite has very high thermal conductivity, it is so good at conducting heat that it has transferred the heat right out of your hand and into the ice. The graphite piece used here is a pyrolytic graphite piece which is very pure and highly ordered form of graphite.