Overview:

Students investigate how energy, in the form of heat, can be transferred and conserved by wrapping containers of hot water and containers of ice in different insulating and conducting materials.

Objectives:

The student will:
- identify the qualities of insulators and conductors;
- identify constants and manipulate variables in an investigation;
- understand that heat energy is retained (conserved) through the use of insulators and dispersed (transferred) by conductors;
- accurately use thermometers to the nearest degree; and
- create and interpret data representations.

Targeted Alaska Grade Level Expectations:

Science

[3] SB2.1 The student demonstrates an understanding of how energy can be transformed, transferred, and conserved by classifying materials as insulators or conductors (i.e., fur, metal, wood, plastic) and identifying their applications.

[4] SB2.1 The student demonstrates an understanding of how energy can be transformed, transferred, and conserved by investigating the effectiveness of different insulating and conducting materials with respect to heat flow and record the results.

Math

[3] S&P-1 The student demonstrates an ability to classify and organize data by [designing an investigation and collecting, recording L], organizing, displaying, or explaining the classification of data in real-world problems (e.g., literature, self, or family), using bar graphs, and [Venn diagrams L].

[3] MEA-2 The student demonstrates understanding of measurable attributes by comparing and ordering objects according to measurable attributes (calendar, length, [temperature, weight, area, or volume L]).

Vocabulary:

insulator –a material that blocks or slows down the passage of sound, heat, or electricity. Rubber is a good insulator of electricity

conductor – a material or an object through which heat, electricity, light, or sound can flow easily. Copper is a good conductor of heat and electricity

Whole Picture:

In Interior Alaska, heat and cold are critical and can mean the difference between life and death. Understanding how heat energy is transferred and conserved can help one make informed decisions about how best to stay safe in a harsh environment and make life more convenient and comfortable.

Materials:

- Glass jars and lids (1 per group)
- Copy paper boxes or boxes large enough to hold jar and insulating material (1 per group)
- Thermometers (1 per group)
- Chart paper
- Pencils
- Insulating materials: cotton/polyester quilt batting, down vests, wool sweaters, other locally available materials that students brainstorm as possible insulators (moss, feathers, fur, sawdust, foam peanuts, sealed-air packaging materials, etc.)

- Stopwatch
- STUDENT LAB: "Keep it Warm" and "Data Collection Graph"
- STUDENT WORKSHEET: "Insulators Word Search"

Activity Preparation:

1. Collect materials listed above.
2. Calibrate thermometers.

Activity Procedure:

1. Ask students to consider the questions: "How can we keep something warm, warm?" and "How can we keep something cold, cold?" Respond to one of the aforementioned questions on a sheet of blank paper with a few illustrated sentences. Collect work and group responses by "warm"/"cold" and read what students had to say out loud.
2. If students did not use any local examples, add some to the mix and ask students which group your suggestion belongs to. If students used the word "insulation" in their responses, key in on it and mention that insulation is a method by which we can retain, or conserve, heat energy. Be clear that insulators do not make heat energy, but trap it or prevent it from entering a container.
3. Task students to conduct an experiment to see what materials do the best job of conserving heat energy. Remind students that an experiment tests a prediction, is repeatable, and limits variables for clear results. Show them some of the insulating materials you have supplied and ask them to think about other locally available materials they might like to try. Ask students to look at the materials to be used/suggested and create a best guess as to which they think will do the best job. Record hypotheses on chart paper.
4. Explain the parameters of the experiment. Student teams will be given a copy paper box or box large enough to hold jar and insulating material, glass jar with water heated to a set degree (the water should be heated in a large hot pot, or in a microwave for a consistent amount of time), glass jar lid, and material in which to wrap or pack their jar. Explain the constants (things that are the same) for each group are the initial water temperature, glass jar, empty copy box, and measurement time interval. What will vary is the insulating material.
5. Students will take a temperature reading of the water in the glass jar every 5 minutes for 45 minutes and record their reading on the data page. While waiting for next measurement students can work on insulator vocabulary word search.
6. Students transfer their recorded data to the results graph.
7. Lead a discussion that compares results and ask students to make conclusions regarding the performance of the materials. Encourage them to use the vocabulary: insulator, conserve, heat energy, transfer. How did the results compare to their prediction? Why might their prediction been incorrect?
8. Ask students to think about the results and consider how what they have discovered could be applied in a local context? For example: sawdust filled coats? Wrap houses in down coverings?
   Why do we not use the best insulators for all applications?
9. Ask for suggestions for how the experiment could be changed or extended.

Extension Ideas:

10. Consider trying "Keep it Cold," by repeating the experiment with ice cubes in the glass jar instead of hot water. Would the same insulators that kept the water hot, keep the ice from melting for the longest amount of time? Measure the volume of water that has melted at given intervals.
11. Extend the lesson as an investigation of conductors. How could the hot water be made to transfer its heat energy the faster than the least effective insulators? What would the fastest way to conduct ambient temperature, in the classroom, to the ice in the glass jar?
12. Using the hot water jar, demonstrate that if dipped in cold water, it will cool rapidly, versus if it is surrounded by cold dry air in a refrigerator/freezer. Now, make the analogy with someone falling in ice water in Alaska versus someone standing in very cold dry air in the winter. Conclude with a short explanation of

hypothermia.

Answers:

STUDENT LAB (optional): "Keep it Warm"
Answers will vary

STUDENT WORKSHEET: "Insulators Word Search"
Students will find and circle vocabulary words from the lesson

Insulation

C J U L R Z I I Q E X I Y H U
X T O I N S U L A T I O N P G
Z F E R U T A R E P M E T I Z
G S T M E I M J Y M B C F N A
U O Z H E A T N D R S M I S E
T N Z U E F N F L Z Q Z C U B
E Y G R E N E J Y B I O X L Z
G J M I Q F V P W I S W G A B
D P N E O J R Q O S P M O T P
L Z O F M L E I U V E M H O E
O N X N A H K Y N A D A E R B
C O N D U C T O R T A U I R P
G B I K R E R E F S N A R T T
D D R V F Y O J E I Q O K Q O
L C V E V R E S N O C M F O G

COLD
CONDUCTOR
CONSERVE
ENERGY
HEAT
INSULATION
INSULATOR
TEMPERATURE

NAME: _____

KEEP IT WARM

Testable Question:

Which material is the best insulator?

Hypothesis:

I think the _____ will conserve the water's heat energy for the longest amount of time.

Investigation:

Materials:

- Copy paper box or box large enough to hold jar and insulating material
- Glass jar and lid
- Heated water
- Thermometer
- Insulating materials
- Stopwatch

Procedure:

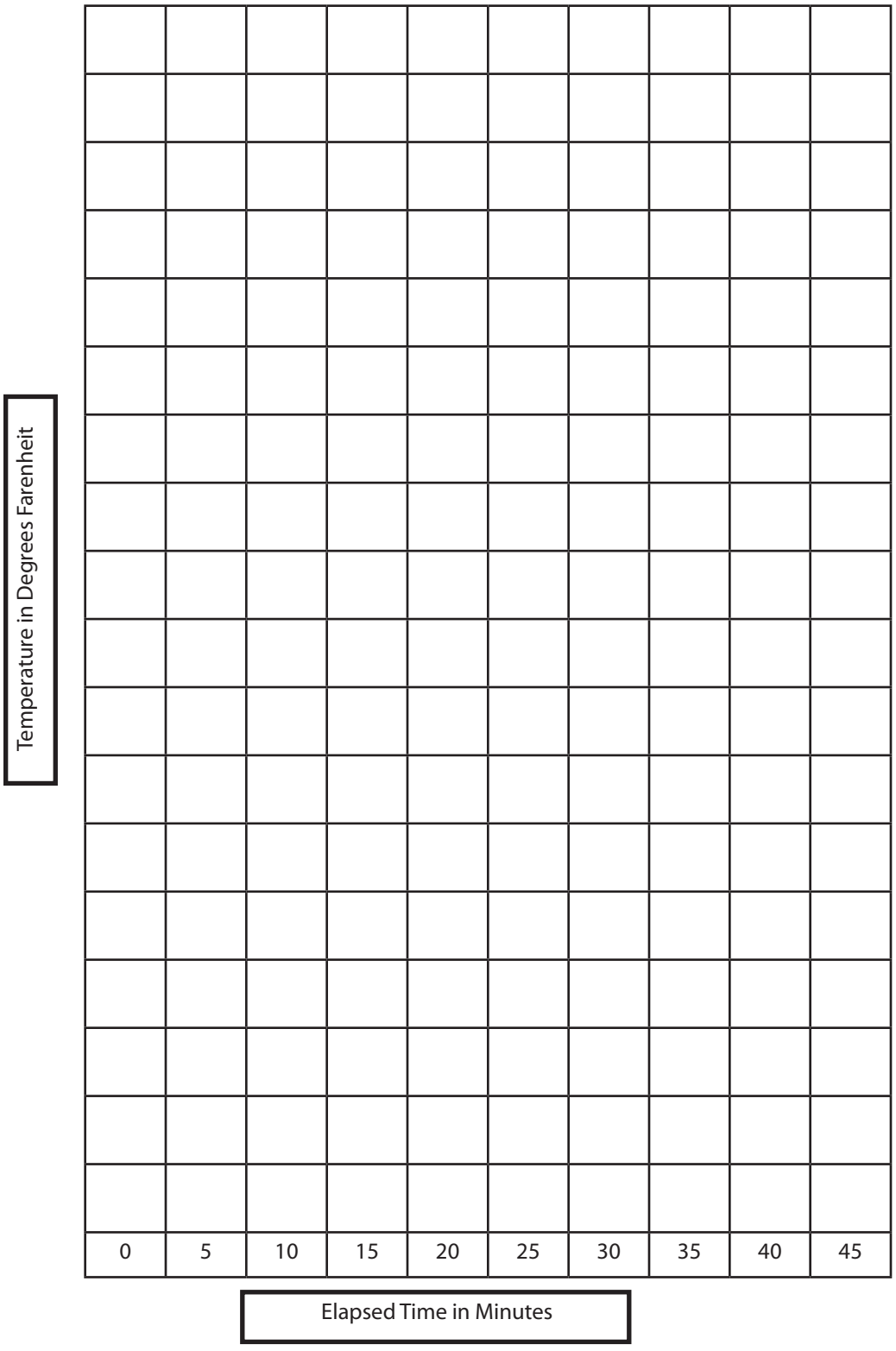
1. Collect all materials, except the heated water.
2. Prepare the insulating testing box by setting insulating material in the box, ready to accept the glass jar.
3. Teacher will pour heated water into the glass jar. Secure lid and place it in insulating material and begin countdown stopwatch for five minutes.
4. Work on "Insulators Word Search" while waiting for time to elapse.
5. At five minutes, measure water temperature and record results. Place back in box and begin timer again. Repeat until all 9 measures have been recorded.

Data:

Water Temperature

Elapsed time (min.)	5	10	15	20	25	30	35	40	45
Temperature Farenheit									

1. How well did your insulating material work? _____



NAME: _____ STUDENT WORKSHEET

INSULATORS WORD SEARCH

Insulation

C J U L R Z I I Q E X I Y H U
X T O I N S U L A T I O N P G
Z F E R U T A R E P M E T I Z
G S T M E I M J Y M B C F N A
U O Z H E A T N D R S M I S E
T N Z U E F N F L Z Q Z C U B
E Y G R E N E J Y B I O X L Z
G J M I Q F V P W I S W G A B
D P N E O J R Q O S P M O T P
L Z O F M L E I U V E M H O E
O N X N A H K Y N A D A E R B
C O N D U C T O R T A U I R P
G B I K R E R E F S N A R T T
D D R V F Y O J E I Q O K Q O
L C V E V R E S N O C M F O G

COLD
CONDUCTOR
CONSERVE
ENERGY
HEAT
INSULATION
INSULATOR
TEMPERATURE