Teaching Objectives:

- Students will observe and understand changes in states of matter.
- Students will understand conservation of energy and heat transfer.
- Students will make measurements, observe and collect data.

Recommended Grade Level: Adaptable for K-8 (optimal with 4-8)

Estimated Prep Time: 25 minutes + time to freeze ice cubes

Estimated Activity Run Time: 1 hour

Key concepts and definitions of terms:

**Insulation:** Prevents energy from transferring from an object to its surroundings, and keeps temperature from changing. Insulation can keep warm objects warm and cold objects cold. Some materials are better insulators than others.

**Heat transfer:** Occurs between objects with different temperatures.

**Freezing point:** The temperature at which a liquid becomes a solid.

Materials:

- 1 small dish per group
- Tape (masking tape works well)
- Felt
- Aluminum foil
- Coffee filters
- Newspaper
- Fleece
- Styrofoam
- Ice cubes
- Scale
- Clock
- Small plastic cups (one per student)
- Yarn
- Salt
**Preparation:**

- Cut the insulation materials you choose to use by tracing the **Template** and marking the inner lines from the template onto the material. You can use the materials listed or choose other materials that you have available. For younger students you might want to pre-assemble them into cubes using masking tape, older students will fold the templates to construct the cubes themselves. If you know the students are capable they could also trace and cut out the template themselves, although this would take longer.
- You may want to prepare one example cube to demonstrate when explaining to the students how to make theirs.
- Keep ice cubes in a Styrofoam chest or freezer until it is time to start activity.
- Prepare small containers of salt so each student has their own, and pre-cut 1 piece of 12” yarn per student.

**Safety Information:**

- Everything in this activity is safe to touch so there are no specific safety precautions to take. However, it is always a good idea to wear goggles and be as safe as possible!

**Procedure:**

1. Divide the students into as many groups as there are insulation materials, so each group is responsible for their specific material.
2. Announce that today we are having a backwards race, to see which material makes ice melt the slowest.
3. Ask the students if they have any ideas of what insulation is, and if they can tell you any examples that they know of from their prior experiences (winter jackets, buildings and homes, thermos are all good answers).
4. Ask the students which material they think will be the best insulator, and why? Have them write down their prediction on the **Handout**.
5. Announce which group will be using which material.
6. Allow time for each group to construct their “race car” with the pre-cut insulation materials and tape. Showing them an example of the completed cube so they understand how to fold and tape it will be helpful. They should leave the top of the box open so that they can put the ice cube in before taping it shut.
7. Have one group at a time come up to the scale and weigh their ice cube racer, and announce the weight to the class so they can all fill in the table on their **Handout**. Try to minimize handling time of ice so that it will not melt excessively before the race starts.
8. Have the students put their racer (ice cube) in the “racecar” they constructed and record the start time on **Handout**. Depending on how much time you have for the activity the race should last 15 or 20 minutes. Set the racecars
aside on their dishes to catch any melted ice that leaks and collect the materials that were used to build the “racecars”.

9. Explain that while the race is going on we can’t touch or interfere in any way with the racers, so we’re going to do another activity in the meantime.

10. Hand each student a small cup, a piece of pre-cut yarn, and a small container of salt. Now pour a small amount of water into each student’s cup, and place an ice cube in as well.

11. Ask the students how they could get the ice cube out of the water without touching the ice cube, and only using the materials they have in front of them.

12. Have them try out their predictions, and if they figure out how to do this on their own then let them continue and explain the scientific concept behind it (Please refer to Why it works). If they aren’t sure how to do it then explain to them that putting salt on ice lowers the freezing point, so it will melt and refreeze to the yarn, allowing you to pull the ice cube out with the string. Let them experiment with this and discuss the concept of putting salt on icy roads in the winter.

13. At this point the ice cube race should be almost complete, so you can collect the materials from the salt & string activity and bring out the ice cubes in their “racecars”.

14. Redistribute the racers to the group that made them and have each group come up one at a time to weigh their ice cube. Have everyone record the mass on his or her Handout table. Let everyone observe the ice cubes after they have been removed from the insulating materials, and compare them to the control ice cube.

15. Find the total change in mass by subtracting the mass after from the mass before and determine which ice cube melted the most and which the least, and put them in order on the Handout.

16. Answer questions on Handout and discuss what happened and the application of insulation to saving energy and keeping our body temperature regulated.

**Clean-up:**

- Melted ice can go in the sink, insulation materials that can be re-used should be saved.
Why it works:

*Insulation race*: Examples of insulation are everywhere. We wear clothes to maintain appropriate body temperature. Buildings and homes use insulation to be more energy efficient. Animals have fur coats and fat to insulate them. Insulation is the reduction of heat transfer between objects. Heat flow occurs between objects with different temperatures, which is why your hands will feel warmer if you hold a mug of tea or hot chocolate. Good insulation can keep warm objects warm and cold objects cold. This explains why insulation in an attic keeps the cool air conditioning from escaping and simultaneously keeping hot air outside from entering. This is also how your winter jacket keeps you warm.

Insulation does not let electrons flow easily, which is the opposite of what a conductor does. Insulators oppose electrical current, while conductors conduct electrical current because they have free electrons that can be shared with other atoms.

The earth also regulates temperature by using insulation! The earth is heated by the sun, and the atmosphere keeps that heat from transferring away, keeping the planet at an appropriate temperature.

*Ice cube on a string*: Salt lowers the freezing point of ice, melting the ice in the cup more easily. This is why trucks come around to put salt on icy roads in the winter and why you might put salt out on the steps where you live. Pure water freezes at 0 °C, and adding salt lowers this because the molecular structure of salt disrupts the structure of ice and reduces the concentration of pure water. When you put salt on an ice cube, the melted water takes some of the salt with it when it flows away. There is now less salt in that spot which causes the freezing point to rise again. The water refreezes to the string and allows you to lift the ice cube out of the water.

References:


*Cube Template* - Cube will measure 1.75 x 1.75 x 1.75"
Handout:
Name: _________________________________ Date: ___________

-INSULATION RACE-

ON YOUR MARK…

GET SET…

GO!!!

Today’s you and your team will be racing BACKWARDS, to see who is the slowest racer! Does your racecar have what it takes to keep ice from melting? You and your team will have a racer (an ice cube) and construct your own “racecar” to keep your ice cube from melting. Let’s find out what material is the best insulator!

1. What material do you predict will make the ice melt the fastest?

Why?

2. What material do you predict will make the ice melt the slowest?

Why?
Let’s Race!

Start time: ______________
End time: ______________

<table>
<thead>
<tr>
<th>Material</th>
<th>Mass before</th>
<th>Mass after</th>
<th>Change in Mass (Mass before-Mass after)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What do you observe about the ice cubes now that the race has ended?

Write the insulation materials in decreasing order, starting with the BEST insulator as #1

1. ________________________________

2. ________________________________

3. ________________________________

4. ________________________________

5. ________________________________

6. ________________________________

Do these results surprise you? Why or why not?
Why did we use a control ice cube (the ice cube with no insulator)?

If you could do the race again, what other materials would you try?

Why?

Do you think we would get different results if we did this outdoors?