Lesson Title:	"What's in the Sled?" STEM: Building the Best Insulated Water Bottle
Background Information	
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Grade Level/ Subject:	4-8 Science with vertical extensions K12
Learning Objectives/ Essential Questions:	○ How do mushers keep their beverages from freezing while racing? ○ How do sled dogs keep warm in the cold weather? ○ How can we use our observations of insulating materials to design the best insulated water bottle? ○ After we perform our experiment, what questions can we ask to further our own inquiry?
Standards Addressed	Next Generation Science Standards (NGSS) MS-PS1-4 Matter and its Interactions: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. MS-PS3-3 Energy: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. MS-ETS1-1 Engineering Design: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. Texas Essential Knowledge and Standards (TEKS) Grade 5 1-4 Scientific Investigation and Reasoning 5 Matter and Energy
Materials Needed:	1. Plastic or glass bottles with screw-on lids 2. Warm or room-temperature water 3. Freezer, refrigerator, or a cold outdoors 4. Materials for insulating such as the kinds of things mushers would have readily available or be able to find at checkpoints: fleece, waterproof jacket fabric, wool socks, tinfoil, straw, plastic such as bags or wrap, ace bandages, flannel, fur, etc. 5. Electrical tape 6. Thermometer 7. Scissors 8. Pencil and recording sheet 9. Timing device such as timer or cell phone

Procedure	
Engagement:	Ask if they have ever had to stay warm in a cold situation—how did they dress? What do they know about how dogs keep warm in the cold while living outside? Show several different water bottles and insulated cups. Ask what materials students think they are made of. Explain that dogs are insulated by two layers of fur, the undercoat which is thick and warm, and the outer coat. Similarly, mushers wear different insulating layers to keep warm while on the trail. Thermal energy passes from hot to cold areas. The speed of this energy transfer depends on whether the substance it is passing through is a conductor or an insulator.
Lesson:	Explain that mushers need to stay hydrated on the trail. They need their beverages to stay liquid without freezing. Can students help them build an insulated bottle using available resources? Have students follow the steps to ask questions, propose hypotheses, and design an experiment. Create groups of 2-3 students. 1. Review the steps of the Scientific Process. 2. Have students make observations about different kinds of water bottles or the types of layers in their jackets. 3. Have students ask their questions. They might want to research what kinds of beverages mushers like, what they use to keep their drinks warm, and the temperatures they might encounter on the trail. 4. Show students the types of materials available to mushers on the trail. Pass the materials around and ask the students to discuss them and write observations. 5. Have students write down a hypothesis about which materials might work best. 6. With their partner, students write a prediction about the types of materials they think will keep the water warm the longest. 7. Have students build their insulation around the empty water bottle. 8. When bottles are finished, pour warm water into the bottles. Record the temperature. 9. Put the bottles outside if it's cold, or in a refrigerator or freezer. After ten minutes, record the temperature. Repeat in intervals as your students determine, recording on a single sheet of paper. 10. Graph your temperature. What do you notice? 11. Ask students for new questions they have. Ask them to record their questions and make a new experiment plan.
Conclusion:	Mushers, like dogs, must keep warm during the Iditarod by using different kinds of insulation. They can keep drinks warm on the trail, too.

	Have students discuss their findings in jigsaw partners/teams.
Assessment:	Choose the assessment based on your curriculum and students' needs. Suggestions: What are the steps in the scientific process? What did I learn about thermal energy and what materials insulate best? What calculations can you perform to predict when the water will reach a certain temperature? Then show your work.
Notes:	
Enrichment/ Reinforcement Suggestions:	1. Try different kinds of beverages. 2. Will the bottle keep cold liquid cold? Try the experiment with cold water. What did you notice? 3. Analyze the time/temperature slope using algebra. 4. Use temperature sensors instead of thermometers to collect continuous data over time.
Other:	Sample process 1. Make an observation: there are so many kinds of insulated bottles out there! A quilt was wrapped around the serum on the 1925 serum run. How do mushers keep their drinks warm? How do they keep their bodies warm? How do dogs keep their bodies warm? 2. Ask a question: Which kinds of insulation will best keep water in a bottle warm? I will test different kinds of materials to see which one keeps a bottle of warm water warmest for the longest. 3. Propose a hypothesis: bottles with more than one insulating layer will keep the bottle warmest the longest. 4. Make a prediction: If I use three layers of different materials, my bottle will stay warm longer. 5. Perform an experiment: I will build three layers of insulation for my bottle. Then I will put warm water in the bottle, record the temperature, and then put it outside or in a freezer. I will measure the temperature after 10 minutes, 15 minutes, and 20 minutes. After collecting my data, I will determine which insulated bottle kept the water warmest the longest. 6. Iterate. I will ask new questions to test bottles—should I change the layers? The order of the layers? The outside color?