

## **5E Integrated STEM Lesson Plan**

**Lesson Title:** *Thermal Bird Houses*

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**Topic:** *Ecology, Conservation, Engineering, Physics*

**Targeted Grade Level:** *6th-8th*

**Time Needed:** *10 days*

**Subject Integration:** Ecology, Engineering, Physics, Writing

**Justification:** This lesson is an integration of ecology, physics and engineering with a writing component. Students learn about the basics of biodiversity through the integration of small birds from the Southern Rocky Mountains. The whole unit is an engineering project in which students go through the engineering design process to design a device that will minimize heat transfer from inside to the outside. Students are writing RERUN lab reports to explain their thinking and reasoning through the unit.

**Standards:** MS-LS2-5, MS-PS3-3, MS-ETS1-1 *WHST.6-8.7, RST.6-8.3,5*

### **NGSS Performance Expectations**

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS-ETS1-1. 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.

Science and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts:

<p><b>Engaging in Argument from Evidence</b>  <i>Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).</i></p> <ul style="list-style-type: none"> <li>Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)</li> </ul> <p><b>Constructing Explanations and Designing Solutions</b>  <i>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</i></p> <ul style="list-style-type: none"> <li>Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)</li> </ul> <p><b>Asking Questions and Defining Problems</b>  <i>Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.</i></p> <ul style="list-style-type: none"> <li>Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)</li> </ul>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b></p> <ul style="list-style-type: none"> <li>Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)</li> </ul> <p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)</li> </ul> <p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)</li> </ul> <p><b>ETS1.A: Defining and Delimiting Engineering Problems</b></p> <ul style="list-style-type: none"> <li>The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)</li> </ul> <p><b>ETS1.B: Developing Possible Solutions</b></p> <ul style="list-style-type: none"> <li>There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5)</li> </ul>	<p><b>Stability and Change</b></p> <ul style="list-style-type: none"> <li>Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)</li> </ul> <p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3)</li> </ul>
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**Common Core State Standards:**

Math: *If applicable*

ELA: *WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.*

*RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.*

**ITEEA Standards** *(If applicable)*

**Other Standards** *(as needed)*

**Measurable Student Learning Objectives:**

*Students will be able to design a thermal birdhouse.*

*Students will be able to justify reasoning using evidence from labs.*

*Students will be able to define insulators, conductors, convection, conduction, and radiation*

**Nature of STEM:**

This lesson addresses two nature of science tenants: *Scientific Investigations Uses a Variety of Methods and Science Addresses Questions About the Natural and Material World*. In how scientific investigations make measurements and observations using different methods and tools, students conduct an investigation on heat transfer in a controlled environment. Students have to collect and analyze their own data based off of the heat device they engineer in class. With incorporating the phenomena of the bird houses, students address the problem of birds surviving in the winter in cold climates. This engineering project aids in maintaining biodiversity and through student exploration, students learn about the actions of the loss of biodiversity and how they can maintain it. The nature of engineering is demonstrated in my unit through principle 3. In building the thermal birdhouses, students have to use essential skills such as communication,

collaboration, and creativity. They have to work together on one device, communicate their ideas to each other and respect those ideas. They must also be creative to come up with a working device.

**Engaging Context/Phenomena:** <https://earthobservatory.nasa.gov/images/146800/temperatures-predict-bird-biodiversity>

*The phenomena is Temperatures Predict Bird Biodiversity. The top two images will be shown to students then a discussion followed by the Southern Rocky Mountain image followed by a discussion.*

**Data Integration:**

*Students use the Temperatures Effect Bird Biodiversity to pinpoint locations in the Rocky Mountains where bird populations are affected the most by temperature differences. Using the data, students will analyze it and come to the conclusion that we need to help the birds survive in the winter by creating special thermal birdhouses. Students are collecting their own data from their own thermal birdhouse testing. Students then analyze their collected data through the RERUN method. RERUN stands for Restate, Explain, Results, Uncertainties, New.*

**Differentiation of Instruction:**

*The major need in my classroom is to keep students focused and on track and to make sure that all of my handouts are translated. I will do active monitoring while groups are working and keep students on task by helping them divide tasks. I will keep them on task by using a timer on the board so groups know how much time they have left each day to work. My worksheets will be translated and will be provided to Spanish speaking students side by side with an English copy.*

**Real-life Connection:**

*The real-life connection is that students see small birds in the community throughout the year. They can connect this to their everyday lives by learning how heat works and understanding how heat is transferred.*

**Possible Misconceptions:**

*Heat rises*

*Heat and temperature are the same thing.*

*Fabric adds heat or warms things up*

**Lesson Procedure:**

5E Model	5E Objectives
<p><b><u>Engage</u></b></p> <p>Students will look at the pictures from <a href="https://earthobservatory.nasa.gov/images/146800/temperatures-predict-bird-biodiversity">https://earthobservatory.nasa.gov/images/146800/temperatures-predict-bird-biodiversity</a></p>	<p><b>Procedure:</b> Students will look at the top two pictures from <a href="https://earthobservatory.nasa.gov/images/146800/temperatures-predict-bird-biodiversity">https://earthobservatory.nasa.gov/images/146800/temperatures-predict-bird-biodiversity</a> .</p> <p><i>Teacher will include “Birds are pretty sensitive when it comes to temperature. Some species struggle to keep warm during cold winters. Other birds have expanded their range northward as global climate has warmed. It turns out scientists can use this close relationship between temperatures and bird behavior to predict bird biodiversity.”</i></p> <p><i>Then verbally discuss observations with their group for 3 minutes. The note taker in the group will write down questions that the group has. Next, the students will view the Southern Rocky Mountain pictures.</i></p> <p><i>Teacher note about the Southern Rocky Mountain image: “The first detailed map pair above shows relative temperature (left) and thermal heterogeneity (right) in the southern Rocky Mountains (top). Note the large temperature variations. This is common in mountain environments, where temperatures can change over very short distances due to factors such as elevation.</i></p> <p>The second pair shows relative temperature (left) and thermal heterogeneity (right) in California’s Central Valley. They show that differences in temperature are not just driven by differences in elevation; they can also be influenced by the region’s farms and orchards.”</p> <p><i>Then verbally discuss observations with their group for 3 minutes. The note taker in the group will write down questions that the group has. As a group, students will go through their questions and rewrite them until they are open-ended questions. As a class, we will go over the questions and</i></p>

	<p><i>post them on a driving question board in the front of the room. We will go over the questions, guiding students to the conclusion that something is happening here involving temperature and bird populations.</i></p> <p><b>Modifications</b> <i>Groups are random. The spoken quote will be typed out and passed out to students in both English and Spanish.</i></p> <p><b>Standards Addressed</b> <i>MS-LS2-5</i></p> <p><b>Formative/Summative Assessments</b> <i>Actively monitor the discussion and keep them on task. Check post-its for being open-ended and not yes/no.</i></p> <p><b>Resources</b> <a href="https://earthobservatory.nasa.gov/images/146800/temperatures-predict-bird-biodiversity">https://earthobservatory.nasa.gov/images/146800/temperatures-predict-bird-biodiversity</a></p> <p><i>post-it notes.</i></p> <p><i>large poster paper</i></p> <p><i>Student work packet (see attached)</i></p>
<p><b><u>Explore</u></b></p>	<p><b>Procedure:</b></p> <p><i>Day 1: Groups will be provided with a one page excerpt of the article with their assignment (Packet attached) on it. As a group, students will read the article and come up with new questions for the DQB. After reading, students will post their questions and engage in discussion. The end goal of the discussion is that students want to help the bird live throughout the winter in their habitats. Students should come to the conclusion of building heated birdhouses.</i></p> <p><i>As a class, go over the criteria and constraints for the assignment. Create a list of materials that could be used. Students will have time to conduct research on heat and heat transfer.</i></p> <p><i>Day 2: Stations (see attached for lab)</i></p> <p><i>6 stations to test insulators and conductors. With their groups, students will go to each of the stations and conduct a mini lab to see if the item is an insulator or a conductor. STATIONS DO</i></p>

	<p><i>NOT HAVE TO BE COMPLETED IN ANY SPECIFIC ORDER. After the lab, groups will write a RERUN lab analysis.</i></p> <p><b>Modifications</b> <i>The article will be in both English and Spanish. Lab stations in both English and Spanish.</i></p> <p><b>Standards Addressed</b> <i>MS-LS2-5, MS-PS3-3, RST.6-8.3</i></p> <p><b>Formative/Summative Assessments</b> <i>Completion of stations and RERUN lab analysis.</i></p> <p><b>Resources</b></p> <p><i>Article (Student Work Packet)</i></p> <p><i>Lab Stations: 6 Aluminum foil lined boxes, 6 Clamp lights, 6 Thermometers, 12 popsicle sticks, aluminum foil square, mylar square, black construction paper square, white construction paper square, white foam square, black foam square</i></p>
<p><b><u>Explain</u></b></p>	<p><b>Procedure:</b></p> <p><i>As a class, students will use the station lab to define insulators and conductors. Students will view Crash Course: Heat Transfer <a href="https://youtu.be/YK7G6l_K6sA">https://youtu.be/YK7G6l_K6sA</a>. Throughout the lesson, students can add or modify post-its that are on the DQB.</i></p> <p><b>Modifications</b> <i>Captions for the video. Students can create their graffiti vocab online.</i></p> <p><b>Standards Addressed</b> <i>MS-PS3-3</i></p> <p><b>Formative/Summative Assessments</b> <i>Students will create a graffiti page for one of the vocabulary terms that we discussed today, Insulator, Conductor, Convection, Conduction, or Radiation.</i></p> <p><b>Resources</b></p> <p><i>Post-it Notes</i></p> <p><i>Grffiti Vocab Worksheet (Student Work Packet)</i></p>

	<i>Coloring materials</i>
<b><u>Elaborate</u></b>	<p><b>Procedure:</b> <i>Students will create a blueprint of their birdhouse. Blueprints must be labeled with size dimensions and materials. Once each group is done, blueprints will be exchanged and evaluated by another group. After 5 minutes, blueprints will be given back to the original groups. Groups will have time to work on their blueprint modifications. When groups are done, blueprints must be approved by the teacher. Once approved, groups can start building their thermal birdhouse. Groups will get three full class periods to build before initial testing day. On initial testing day, groups will test out their birdhouses with a 50 mL hot water beaker for 10 minutes. After the testing, results will be posted on the board and groups will complete the analysis section. The next two days will be used for birdhouse modifications. Students will complete their final thermal birdhouse test and complete a RERUN lab analysis.</i></p> <p><b>Modifications</b> <i>Students may get distracted with all of the work going on so active monitoring is key. A timer will be available for student's to know how much time is available.</i></p> <p><b>Standards Addressed</b> <i>MS-PS3-3, MS-ETS1-1, WHST.6-8.7, RST.6-8.3</i></p> <p><b>Formative/Summative Assessments</b> <i>Blueprints will be checked by another group and by the teacher before being allowed to build. Active monitoring of modifications being recorded on the modifications page in the handout.</i></p> <p><b>Resources</b></p> <p><i>Student Work Packet</i></p> <p><i>Birdhouse Materials-vary on classroom and student need</i></p> <p><i>50 mL beaker-one per group</i></p> <p><i>Hot Water</i></p> <p><i>Thermometers-one per group</i></p>

<p><b>Evaluate</b></p>	<p><b>Procedure:</b> <i>Group thermal Birdhouses will be graded based on a rubric. Groups have to submit a device, labeled diagram, and a RERUN lab analysis.</i></p> <p><i>Extension: Groups have to present their birdhouse devices and diagrams to a fictitious company (rest of the class) and be able to explain modifications and materials used.</i></p> <p><b>Modifications</b> <i>Students may be given sentence starters to help with the RERUN.</i></p> <p><b>Standards Addressed</b> <i>MS-PS3-3, WHST.6-8.7</i></p> <p><b>Formative/Summative Assessments</b> <i>Rubric for the Birdhouse and completion of RERUN lab analysis</i></p> <p><b>Resources</b></p> <p><i>Student Work Packet</i></p> <p><i>Rubric</i></p>
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**Teacher Background:**

*Definition of heat, temperature, and the difference between the two, <https://www.physicstutorials.org/home/heat-temperature-and-thermal-expansion/heat-and-heat-vs-temperature>*

*Definition of conductors and insulators, with examples.*

*<https://www.physicsclassroom.com/class/estatics/Lesson-1/Conductors-and-Insulators#:~:text=Conductors%20allow%20for%20charge%20transfer,atom%20and%20molecule%20to%20molecule.&text=The%20insulator%20serves%20as%20a,top%20of%20a%20lab%20table.>*

*Definition of conduction, convection, and radiation. <https://www.physicstutorials.org/home/heat-temperature-and-thermal-expansion/heat-transfer-via-conduction-convection-and-radiation>*

*RERUN. Science Formative Assessment, Volume 1 by Page Keeley Fact 52*