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| **TEAM Lesson Plan Template** | |
| Teacher: Ray Whitmer | |
| Subject/Grade: 6th grade | |
| Lesson Title: Heat the Steel / Heat the aluminum | |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| 6.PS3.4 Conduct an investigation to demonstrate the way that heat (thermal energy) moves among objects through radiation, conduction, or convection.  This lesson emphasizes:  Engineering practice: Analyzing and interpreting data  CCC: energy and matter, cause and effect  Learning performance:  The students will gather and interpret data to demonstrate heat movement by conduction through a solid emphasizing the CCC of energy and matter. | |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledge  Student-Friendly (I Can Statement) |
| I can graph heat as a function of time.  I can operate an IR thermometer.  I can determine if heat transfer is by radiation, conduction, or convection. | |
| **MATERIALS AND RESOURCES** | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook. |
| **Activities & Materials**  The activity requires sufficiently many electrical outlets for each group of students to operate a hair dryer. **Do not plug multiple hair dryers into a power strip. Each hair dryer will probably draw at least 1500 watts, and normal power strips are typically rated at 1875 watts. Two Hair Dryers > Power Strip Capacity.**  **Per group/pair:** Worksheet, pencil (ideally a regular pencil and two colored pencils, one color for steel, one color for aluminum), wood pieces, steel bar, aluminum bar, hair dryer, thermometer  **What if the technology is not working?**  If there are not enough hair dryers to perform this experiment or the hair dryers are not working, postpone the experiment.  **Routine for distributing materials**  Place each groups’ materials at the group table before class. | |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| ***Modifications/Plans for Diverse Learners***  ***Differentiation***  ***Flexible Grouping:***  ***Accommodations***  ***\_\_\_ Preferential Seating \_\_\_ Extended Time \_\_\_ Small Group \_\_\_ Peer Tutoring***  ***\_\_\_ Modified Assignments \_\_\_ Other***  ***Early Finishers*: Early finishers should be encouraged to check their plots to make sure that these are useful standalone documents. Check the title. Check the units. Can someone looking at the document next week understand what it means?** | |
| |  |  | | --- | --- | | **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. | | Heat energy can travel by several methods (what are the methods?). This experiment shows that heat can travel through a solid. What is a real world example – Hint: Do you like to cook? If you boil water in a pot, heat has to get through the solid pot. If you bake a potato, heat travels through the potato. | | | **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. | | ***Introductio*n:** Again, what are the three types of heat transfer? \_\_\_ Who can describe them radiation? \_\_ Someone describe convection. \_\_\_ Someone else, describe conduction. \_\_\_ Today we will look at heat traveling through a solid. Which type of heat transfer will we be dealing with? [conduction] *Demonstrate how to set up a steel bar on wooden blocks. Demonstrate how to use the thermometer. Demonstrate how to use the hair dryer.*  **Middle:** Have students complete the worksheet. Monitor their work and provide encouragement. There is no focus in this lesson on the students designing the investigation, so if they have difficulty in setup, help them.  **End/Closure:** As the students analyze and interpret their data, the teacher may walk around the room and ask the students questions about their experiment. For example, the teacher should ask questions such as, “Do the two metals have the same graph?” or “Why do you think that the two metals have different graphs?”. Bring the classroom back together and have a discussion as a whole on how the experiment went.  **Motivating Students:**  Relate to Real World: This experiment is about thermal energy which is related to cooking, the sun, etc.  Verbal Reinforcement: Once the experiment is over, the students will have a class discussion lead by the teacher about what data they found.  **Presenting Instructional Content**  \_\_ Lecture/Notes: Display the lesson objectives  \_\_ Hands-On: The students are conducting an experiment to learn about thermal energy.  ***Instructional strategies:***  ***Input -* Hook (Set):**  Cooking discussion.  **Modeling and Guided Practice:**  The teacher will monitor students’ work and ask questions to prompt them if they are stuck. Throughout the exercise, ensure that each student is recording the calculations.  **Check for Understanding (CFU) –**  ***What am I doing for students that progress at different rates?***  Encourage students to help each other within their groups. If one group is significantly ahead of another, ask one group to help the other. If necessary, provide help with the algebra (the algebra is necessary, but is not a central theme of this activity).  ***What do I do if they get it?***  If they are done early, have the students think of at least five different ways thermal energy is used, or the students may be able to assist other groups in their calculations or reasoning.  ***What do I do if they don’t get it?*** | | | **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. | | **Questioning**  **Knowledge:**  What is thermal energy?  What is another word for thermal energy?  **Comprehension:**  Summarize the differences in what you observed using steel and what you observed using aluminum.  **Application:**  How is cooking an example of transfer of thermal energy?  How is thermal energy transferred from the sun to the earth?  Give an example of thermal energy transfer that we have not talked about in class today.  **Analysis:**  Compare and contrast the steel bar and the aluminum when they were heated by the hair dryer.  Predict the outcome if we would have used a flame instead of a hair dryer.  Explain why you think that the graph would look different if we used another source of heat? (or explain why not)  **Synthesis:**  **Evaluation:**  **Thinking**    \_x\_ **Practical** – Using an IR thermometer is a practical skill used in many industries. (HVAC, construction, manufacturing)  \_x\_ **Analytical** – The students analyze their data to discuss as a class. They have to interpret numbers as a representation of the transfer of thermal energy through a solid.  \_x\_ **Research-based** – The students will conduct an experiment to see how long it takes for the heat to transfer through the steel bar and aluminum.  **\*What am I going to do to give students an opportunity to?**  **1. Generate variety of ideas:**  The students will discuss their data as a group then as a class to generate a variety of ideas about why the steel conducted heat at a different rate than aluminum.  **2. Analyze problems from multiple viewpoints:**  Students must consider the input of each member of their group.  **Problem Solving**  **\_\_\_ Drawing conclusions/Justifying Solutions:** The students must draw conclusions by the data that they interpreted.  **\_\_\_ Observing and Experimenting:** The experiment allows the students to see how thermal energy works as the hair dryer heats the steel bar and aluminum so that they will have a better understanding of thermal energy. | | | |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * Heterogeneous groups of four * Roles. Reader: read instructions and record results; Thermometer holder: measure temperatures; Dryer holder (operate hair dryer); Bar mover (carry and place bars, operate stopwatch). * Group members assume roles by writing their names on the worksheet. * Students should begin class sitting with their group and required equipment at a center or lab table. | |
| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction. |
| ***Assessments:***  **Teacher Made Test:** A future test can include questions such as, “Why was there a difference when using the aluminum as opposed to the steel bar?”  **Exit Ticket:** Described below  *\****Students should achieve \_\_\_\_\_% mastery of this objective: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| ***During the conclusion part of creating an effective lesson plan teachers must sum up the ideas learned from the lesson. A teacher should also relate this information to future and past coursework to provide students with a broad understanding of the ideas learned. It is important to allow students enough time to ask questions, assert assumptions, and summarize the lesson during this part of the lesson plan.***   * ***Review/Summary: wrap up what has been learned and accomplished in the lesson (even if they are in the middle of an exercise, it is still important to summarize to the point where they are now). Ideally involve students in this synthesis.*** * ***Preview for next lesson: link what they did to day with where they are going next.*** * ***Upcoming assignments: remind them of any upcoming assignments.***   ***Today we…. Turn to your partner and…. Let’s review our I Can statements……***  **Exit Ticket:** Why was the steel bar graph different from the aluminum graph? Do you think that the graph would look different if we used another source of heat? Explain your answer.  **Follow-up Activities/Extension *These may be designed to create a longer or more intense lesson. For example, if the class is able to cover the material in a lesson much faster than expected, extensions may prove helpful. Extensions may also be useful in various parts of a lesson where the teacher (and class) decides they should spend more time on a skill or topic.***  ***Reflection: You must reflect on every lesson you teach.*** | |

**NOTES:**

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Thermal Energy

Heat the Steel / Heat the Aluminum Worksheet

Reader (Read instructions, record results): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Thermometer holder (Measure temperature): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dryer holder (Operate hair dryer): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Bar mover (Carry and place bars, operate stopwatch): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. After recording your names, arrange your steel bar on wooden blocks so that you can measure the temperature of one end of the rod without measuring the hair dryer’s temperature.
2. Measure and record the temperature of the near end of the steel bar.
3. Start the stopwatch and start heating the far end of the steel bar. Measure the temperature at regular intervals and produce a plot of temperature vs. time. Label the curve “steel.” Make sure that you label your plot with a title and units.
4. Decide when to stop collecting data. Turn off the hair dryer and quickly measure the temperature at the far (hair dryer) end of the steel bar. What is this temperature? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Explain why you stopped when you did.
6. Arrange your aluminum bar on wooden blocks so that you can measure the temperature of one end of the rod without measuring the hair dryer’s temperature.
7. Measure and record the temperature of the near end of the aluminum bar.
8. Start the stopwatch and start heating the far end of the aluminum bar. Measure the temperature at regular intervals and produce a plot of temperature vs. time. You may draw this plot on the same axes as the curve for steel, but label this one “aluminum.” Make sure that you label your plot with a title and units.
9. Decide when to stop collecting data. Turn off the hair dryer and quickly measure the temperature at the far (hair dryer) end of the aluminum bar. What is this temperature? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Explain, in words, what your plots show:

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