Lesson Update and CRT Addendum	
Lesson/Activity Title: Feel the Heat	**ID: 17-844**
Product Number: EG-2009-02-05-MSFC	**Grade: 9-12**
URL for Lesson: https://www.nasa.gov/pdf/417998main_OTM_Feel_Heat.pdf	
Subject: Heat transfer, infrared radiation, conversion of energy, measurement	
Summary: In this challenge, students follow the engineering design process to: (1) build a solar hot water heater; (2) test to see if it can raise the temperature of water; and (3) use their testing results to improve their heater and get as big a temperature change as possible.	
Materials for lesson: (per heater if making the one suggested) Aluminum foil, cardboard, adjustable lamp, black marker, black paper, 2 paper cups, 3 feet of clear plastic tubing, water container, ruler, scissors, straws, duct tape, thermometer.	

Review and Recommendations	
ALIGNMENT TO STANDARDS	
NGSS	**HS-ESS2**
Common Core State Standards in Mathematics	Not emphasized. Could add: conversion of units of measure.
CULTURAL RESPONSIVE TEACHING (CRT) RECOMMENDATIONS	
5E Lesson/Description	
1. Engage	Incorporate students' prior knowledge of heat transfer: hot pavement/sand, hot surfaces in a vehicle in the summer, water in a hose left in the sun, anyone have solar heaters at home? Have you seen a roof with solar panels? Dark roof vs. lighter colored. Wearing dark clothes in the summer.
2. Explore	Allow the students to translate parts of the project in their own language and then share with other students. A suggestion here would be to allow students to apply proper uses of the solar water heating system at home and in their respective neighborhoods for people such as the poor or homeless who will need heat during winter and cold days. Instead of giving students the design shown, let them brainstorm and design the system from scratch and

	discover the benefit of longer tubes and zig-zag pattern on their own.
3. Explain	There is an opportunity for discussion that students/teachers can take advantage of once the project during the design and after the project is complete. During the brainstorming and design process, the teacher can focus students attending based on the brainstorming questions. The students or kids can exhibit their heaters and discuss how they solved any problems that came up.
4. Expand/Enhance	The teacher or facilitator can have students reflect and brainstorm ways water is heated and use their primary language to create vocabulary words. The class can build a simple larger solar water heater for the classroom using the best design from the lesson scaled up.
5. Evaluate	There are no assessments associated with the lesson. A rubric designed to measure appropriate criteria should be considered. Consider assessing students on their reasoning for using certain materials and provide clear rationale(s) for their designs and be ready to defend.

Additional Resources:

https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/OTM_Feel.html