Thermal Energy Transfer

Target Grade: Middle School

Teacher Prep Time: 60 minutes (the first time to build the cork holders and thermometer sleeves) After that, prep will be 20 minutes or less.

Lesson Time: 100 minutes or 2 class periods

Learning Goals:

- Students will observe how thermal energy transfers from the sun as measured by thermometers.
- Students will investigate the relationship between a burning peanut and the energy that is released through combustion and transferred to a beaker of water.

NGSS:

- MS-PS3-3: Apply scientific principles to design, construct and test a device that either minimizes or maximizes thermal energy transfer.
- MS-PS3-4: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
- Disciplinary Core Ideas
    - PA3.A: Definitions of Energy
        - 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.
    - PS3.B: Conservation of Energy and Energy Transfer
        - The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample and the environment
        - Energy is spontaneously transferred out of hotter regions or objects and into colder ones.
- Cross Cutting Concepts
    - Energy and Matter
        - Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).
        - The transfer of energy can be tracked as energy flows through a designed or neutral system
- Science and Engineering Practice
    - Analyzing and Interpreting Data
        - Analyzing data in 6-8 builds o K-5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data ad error analysis.
            - Analyze and interpret data to determine similarities and differences in findings.

Where this lesson fits in:

- This lesson fits in after learning about forms of energy for both kinetic and potential and the transfers of energy between them. (MS-PS3-1 & MS-PS3-2)

Materials Needed:

SOLAR RADIATION:

Per Group (groups of 4)

3 thermometers

1 Black, 1 white construction paper sleeves to cover thermometers (see attached photos for examples)

1 stop watch for the teacher

PEANUT LAB:

<u>Whole class</u>

Taper Candle and matches

Gram scale to measure to tenths place

<u>Per Group (groups of 2)</u>

Thermometer

Metal can or 250ml beaker

100 ml graduated cylinder

Wire Stand or Ring Stand w/ wire mesh beaker support

Stop watch

Aluminum foil sheet

Cork with pin and foil shield (see attached photos for examples)

Whole, raw peanut

Wood block, 4 in x 1.75 in x 1in

Cup of water

<u>Individual</u>

Peanut Energy worksheet

Goggles

Teacher Prep:

- Cut black and white construction paper large enough to fold over and cover thermometers. Staple the end and sides to make sleeves. (See photos)
- Prepare wine cork
    a. Using pliers, cut off the head end of the straight pin, then insert into end of wine cork so sharp part is pointing up. Cover this end with foil as a heat shield. (see photo)
- Purchase RAW in the shell peanuts. Shell them and keep the kernels that remain whole. The kernels need to be whole to be used in the lab.

- Prepare wire stand if using a coat hanger stand. See photos
- Gather remaining materials.

10 minutes	**Beginning Thoughts** **Engage:** • Have students think/pair/share what they know about the energy from the sun, how this energy gets to earth and how it relates to life on earth. • Ask students to share with their table groups, then discuss as a whole class.
40 minutes	**Explore:** • As a class, read aloud the introduction to the Solar Radiation Lab and make predictions. • Review together the materials needed for the lab. • Review how to read temperatures with a thermometer by placing one so all students can view (under document camera). • The teacher models how to set up the materials. Place one thermometer in the white sleeve, another one in the black sleeve and leave the 3rd one uncovered. • Pass out the materials to the students and have them take beginning temperatures for all 3 thermometers and record it under "0 Min – Beginning" in the table. Place two thermometers in the sleeves • In table groups go outside into the sunshine and find a spot to place the 3 thermometers. (Some could choose asphalt, concrete, grass, track, etc.) Students may choose their location and record. The teacher will call off the time in 1 minute intervals to record the temperatures in table. • Students slide the thermometer up out of sleeve to see the thermometer reading, then slide it back inside. • Continue to record every minute for 5 minutes. • Gather materials and return to the classroom. • Create the triple line graph for their data. • Discuss their results with their group. • Each group will share their graph with the class indicating their site location. • Discuss as a class any similarities or differences observed between the different groups. • Discuss the following questions: 1. What relationship(s) do you see on your graph? (black sleeve should be highest, white sleeve should be lowest) 2. What differences do you see between the maximum/minimum temperatures for each thermometer each group found? 3. Why do you think these differences occurred? (does the location of the thermometer affect the maximums?) 4. a. Which thermometer and/or environment would maximize the thermal energy transfer? b. Which thermometer and/or environment would minimize the thermal energy transfer?

5 minutes	**Beginning Thoughts** ***Engage*** • Ask students to share with their partner the various forms of energy transfers being sure to include both potential and kinetic forms. • Have some students share their examples with the class. •
45 minutes	**Peanut Lab** **Explore** • As a class, read aloud the introduction to the Peanut Energy Lab. • Review together the materials needed for the lab. • Review together as the teacher models how to set up the materials. • Pass out the materials to the students and in partners, have them set up the lab. • Students need to weigh the peanut kernel on the gram scale. If only one scale is available, teacher can walk around to each table and have student's record the mass of their peanut in table on worksheet. • Once the set up is complete with the peanut stuck to the pin and water is measured in the beaker, have students raise their hands to alert the teacher they are ready. • Once the peanut is lit, students will start their stop watches, make observations and record their observations on data tables (front and back pages). • Students will complete individual data charts with information gathered in the lab. • Once completed, share data with another pair of students and discuss comparisons. 1. Students will complete line graph for their water temperature data and explain what their graph shows. 2. With their partner, ask the students to complete the observation questions. 3. Ask students to complete the conclusion a. Describe how energy was transferred and/or transformed. b. Using your evidence/data, explain how you know this.