FIELD TRIP SNACK HOLDER

Grade Level:	**Total Time Required:**
3	4 periods (30 minutes each), approximate

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Lesson Objectives:

In this lesson, students will design and build a reusable snack holder that can keep a snack cold on a hot school bus.

Students will be able to:

1. Demonstrate that light is a form of energy by using a light to warm a piece of material. The temperature of the material will be measured to show the change in heat.
2. Demonstrate that the cover of the material influences the temperature of the material because of how light is either absorbed or reflected.
3. Apply their understanding of light to design a container to keep a snack cool when placed in the sunlight.
4. Use various materials and typical engineering design components (examples provided).
5. Measure lengths using SI Units to design the apparatus and measure temperature in Celsius.

Indiana Standards

3-5.E.1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

Next-Generation Science Standards

4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
3-5.ETS1-1	Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

Science/Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence

Crosscutting Concepts
2. Cause and effect: Mechanism and explanation.

Concepts and Vocabulary

Term	*Defined by a scientist or engineer*	*Defined by a student*
Light	Electromagnetic radiation that has a wavelength in the range from about 4,000 (violet) to about 7,700 (red) angstroms and may be perceived by the normal unaided human eye.	Bright/helps see in the dark
Heat	The transfer of energy from one body to another as a result of a difference in temperature or a change in phase.	How hot something is
Energy	The capacity or power to do work, such as the capacity to move an object (of a given mass) by the application of force. Energy can exist in a variety of forms, such as electrical, mechanical, chemical, thermal, or nuclear, and can be transformed from one form to another. It is measured by the amount of work done, usually in joules or watts.	They have lots of energy when they are moving around a lot.
Reflect	To throw or bend back (light, for example) from a surface.	What you see in the mirror.
Absorb	To take in (all or part of incident radiated energy) and retain the part that is not reflected or transmitted.	Soaks up like a sponge

Equipment, Materials, and Tools

Materials		
Heavy paper (Oak Tag)	Cardboard	Assorted jars and cans
Multiple types of duct tape, including reflective, black, and white (minimum)	Clear plastic wrap	Markers
8” x 11” Picture Frame with glass or Plexiglas	Tape	Wax paper
Aluminum foil	Glue	Acetate sheets
Different colors of fabric		

Tools		
High lumen light source	Scissors	Classroom timer or stopwatch
Reversible liquid crystal temperature labels (10 to 40 Degree C)		

Temperature Measurement Options:

1. Adhesive temperature strips:
   http://www.coleparmer.com/Product/Sixteen_Point_Vertical_Thermometer_with_Adhesive_Backing_90_to_120F_25_pack/WU-90316-04

   http://www.coleparmer.com/Product/Sixteen_Point_Vertical_Thermometer_with_Adhesive_Backing_58_to_88F_25_pack/EW-90316-02

2. Infra-red temperature meter
   http://www.harborfreight.com/infrared-thermometer-93984.html

Safety Guidelines:

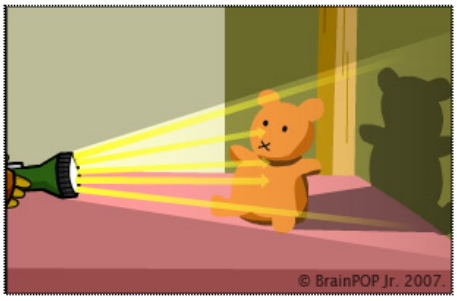
1. Cutting thick paper with scissors will be required.
2. If using the infra-red temperature meter, only the teacher should operate the meter or the teacher should closely supervise student operation of the meter because the meter contains a laser which can cause eye/vision damage (warning: avoid direct eye exposure to the laser).

Science Content - Energy, Light and Optics

There are many forms of energy: 1) heat; 2) electrical; 3) sound; and 4) light. This lesson plan focuses on light energy.

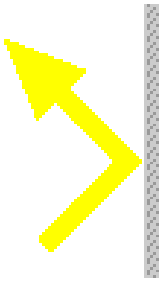
Light moves in straight lines.

Objects can absorb light or, in other words, take it in. The teddy bear below is absorbing the light and no light goes through. The teddy bear creates a shadow.



http://www.brainpopjr.com/science/energy/light/grownups.weml

A surface can also reflect or bounce back light. Objects like a mirror, smooth glass, or water reflect light well.



http://www.kidport.com/reflib/science/Light/ReflectionRefraction.htm

Objects can both absorb and reflect light. Dark surfaces such as the black paper absorb more light than the lighter ones such as the white paper. The darker the color, the less visible light it is reflecting and the more it is absorbing. Since light is energy, absorbed light would increase a materials temperature.

Synopsis of Engineering Design Activity

Synopsis of the Design Activity:

Problem:	Students are going on a field trip at the end of the school year and they need a way to keep their snack cool while it is left in the school bus.
Goal:	Design a reusable snack holder that can regulate the temperature of the snack by absorbing or reflecting light energy.
Who is the client:	Student
End-User:	Student
What is the design:	Design a reusable snack holder that can regulate the temperature of the snack by absorbing or reflecting light energy.
Criteria:	1. The snack holder must be large enough to contain a snack of the student's choosing. 2. The snack holder must be reusable. 3. The snack holder must maintain the snack at a desired temperature while placed in direct sunlight.
Constraints:	1. Materials available for construction. 2. Time. 3. Size of the snack.

Lesson Plan #1 – Inquiry Activity
What is the best way to keep the sun (Light) from heating up a container?

Time: 1-2, 30 minute class sessions

Introduction:

1. As a class, the teacher will lead a discussion about how light is a form of energy that can interact with different materials and ultimately cause the material's temperature to change due to light absorption (see "Science Background").

   Ask: *You leave a drink outside in the summer. What happens to the drink?*

2. In a class discussion, have the students determine which of the provided materials (different colors of tape, fabric, and paper) will absorb the most light energy.

   Ask: *How can we measure the change of temperature of these materials?*

3. Show the students the adhesive temperature strips and describe how they can be used to measure the temperature of different objects and materials.

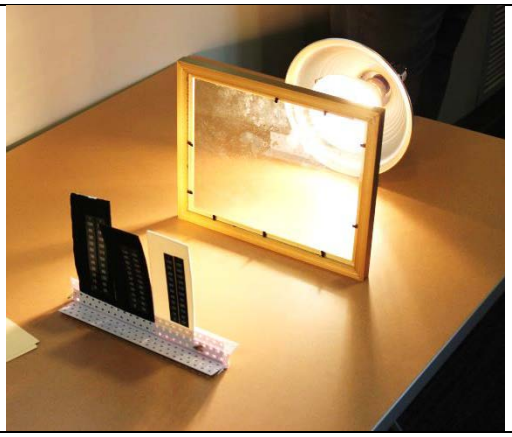
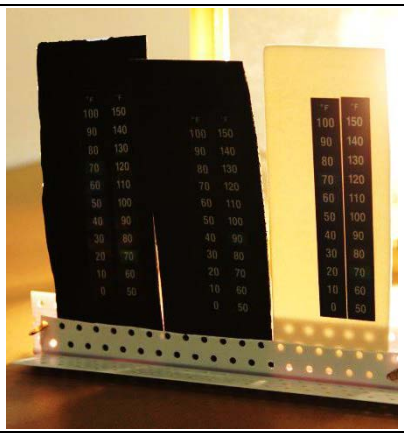
Group Activity: Testing Different Materials using a Test Coupon

1. The students can choose the materials that they would like to test.

2. A heavy piece of paper (oak tag) can be covered using their chosen material. This is called a "test coupon". Only one coupon is needed for each type of material to be tested (see suggested materials on the next page).

3. Apply an adhesive temperature strip to the back of each test coupon.

4. Construct the testing set-up as shown in the following figure, using a strong lamp positioned across from where the test coupons will be located during testing. Place a rectangle of glass or Plexiglas between the lamp and test coupon location (an empty picture frame will work). This will simulate the school bus window; however, it also serves as an important testing requirement. The frame (window) will block most of the heat from the bulb filament but allow the light energy to pass.

	
Test Coupons and Lamp Set-up	Test Coupons and Adhesive Temperature Strips

5. Have the students copy the sample data table shown below into their lab notebooks. Explain to the students that once the test coupons are placed in the light, the students will record the temperature of each test coupon (that is, each "Material") by reading the value off the adhesive temperature strip every 5 minutes for the next 15-20 minutes. Note: to facilitate these multiple temperature readings in less than a minute, the instructor may choose to assign a different student to monitor each test coupon during the course of the experiment.

6. To begin the experiment, read the temperature of each test coupon. Record the data in the "Temperature at Start (0 min)" column of the data table.

7. Next, start the classroom timer (or stop-watch) and place the test coupons in position, located across from the lamp and directly facing the light, such that the adhesive temperature strip is not directly facing the light but is instead "behind" the test coupon (see previous testing set-up figure).

8. While the students are waiting between temperature measurements, have them sketch the testing set-up in their lab notebooks, clearly labelling all the important parts of the set-up.

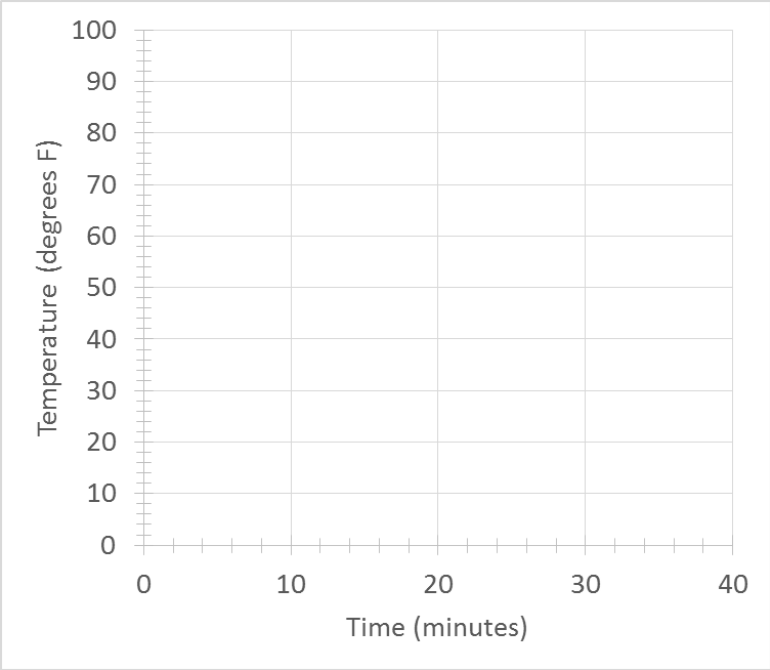
9. Continue to measure the temperature of each test coupon at 5-minute intervals and record the values in the data table. A noticeable change in temperature should occur for most of the materials within 15-20 minutes, depending on the material.

10. Together as a class, make a graph of the data using the template on the next page.

Sample data table with suggested testing materials.

Materials	**Temperature (°C) at Start (0 min)**	**Temperature (°C) at 5 min**	**Temperature (°C) at 10 min**	**Temperature (°C) at 15 min**
Wax paper				
Aluminum foil				
Black cloth				
White paper				
…				

Sample graph that the instructor can help the students to complete as a group.
(see Appendix for both Celsius and Fahrenheit graphs)



Group Discussion and Wrap-Up:

Discuss why the temperature changed a lot for some samples (like the black cloth, which strongly absorbs light energy) and only changed a little for other materials (like the aluminum foil, which strongly reflects light energy).

In their notebooks, have the students rank the materials from the best light absorber (which would display the greatest temperature increase over time) to the worst light absorber (which would display the smallest temperature increase over time).

Lesson Plan #2
Design Challenge

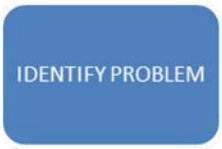
Time: two 30-minute sessions

Goal: Design a reusable snack holder that can regulate the temperature of the snack by absorbing or reflecting light energy.

Procedures:

1. Students should be organized into small groups (2-3 per group).

2. Distribute, read aloud, and discuss the design brief. Ask the following:
   What is the problem?
   Who is the client?
   Who is the user?
   What are the criteria?
   What are the constraints?
   What materials and tools have been provided?



3. Have students respond to the above questions in their notebooks. Discuss responses with class.

4. Review with the students
   a. Show the students the materials that are available for the activity.

   b. Remind students to use the materials and skills learned from the inquiry sessions to solve the problem.

   c. Each team of students should discuss what snack they would like to have on the field trip (e.g., juice box, apple, pudding cup, string cheese).

   d. The snack should be kept "cold" within their reusable snack holder.

   e. Students should write this information in their notebooks.

5. The students should be given the snack template (a picture of the snack provided in Appendix) or an empty "snack" package (e.g. an empty juice box, or a plastic toy fruit). They will need to design their snack container so that the snack template (or "snack" package) will fit inside.

6. Instruct students to individually brainstorm ideas and apply what they have learned about how light interacts with different materials.

7. Have students list or sketch their own ideas in their notebooks. Then have them choose their best idea to use as an individual design plan. Remind students that sketches should be large, neatly drawn, and clearly labeled showing dimensions and materials.

8. Students should then meet with their team and share plans, explaining how they expect their design to solve the problem. Each team should decide on a 'final' group design, which can be a combination of ideas or a specific design from an individual within the group. Have each team member sketch the final design. Each of the students' sketches should be detailed to allow anyone else to construct the design by looking at the drawing.

9. Student teams will construct their design.

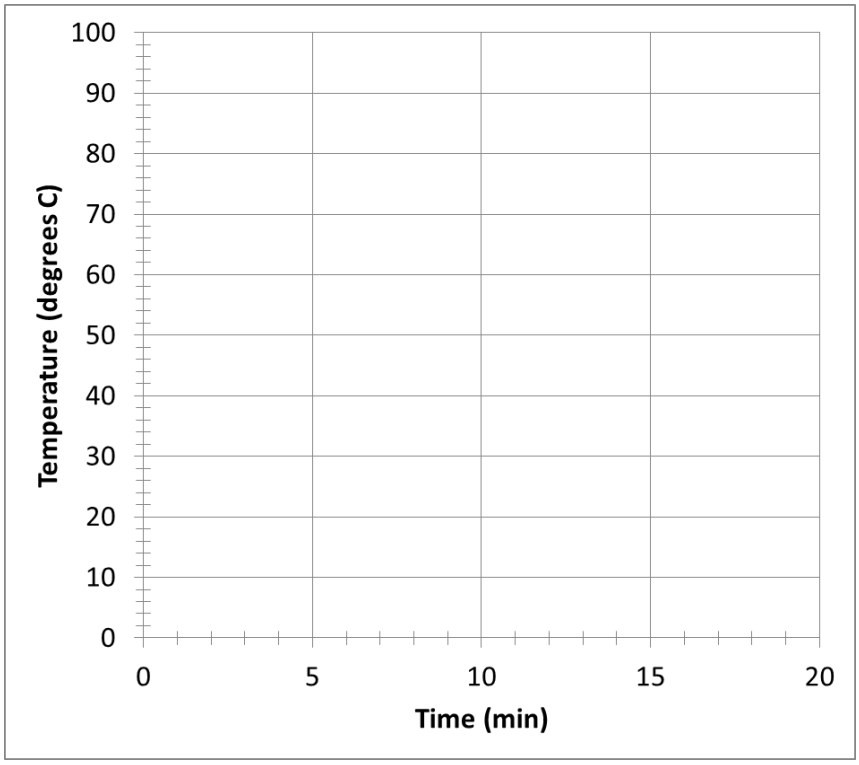
10. Test the design when completed, taking notes about what is working well and what could be improved.
    a. After constructing their snack containers, the students should place (and leave) an adhesive temperature label inside their container, take a temperature measurement using the adhesive temperature label, and record the results in their notebooks, and shut the lid their snack container. This will be the "0 minute" recording.

    b. The students should then place the snack containers in a sunny window or in front of the lamp. After 5 minutes, the students should open the lid of their snack container briefly to take another temperature measurement from the adhesive temperature label, record the results in their notebooks, and shut the lid to their snack container. The students should retake the temperature measurement every 5 (if using a lamp) to 10 (if using sun in a window) minutes using an adhesive temperature label and record the results in their notebooks. After 30 minutes (for experiments using lamp) or 1 hour (for experiments using sun), the testing will be completed.

    c. The students should plot their data (temperature vs. time) on the graph paper. An example template for a graph is provided below.

    d. The students should discuss whether their snack container is keeping the snack at a constant temperature, or whether the temperature is rising. If the temperature is rising, the students should discuss what could be improved about the snack container design or their testing strategy.

Sample graph that the instructor can help the students to complete as a group.



11. Each group presents their design to the whole class and then demonstrates their prototype for the class.

12. After all groups have presented, each student will answer the following questions in their notebook:
    - *How effective (good) was your design? How do you know?*
    - *What would you change in your design? Why?*
    - *Do your results match what you observed in the Inquiry Activity? Why or Why not?*

13. If time permits, encourage students to redesign based on test results. If time does not permit, instruct students to sketch a new design in notebook based on change mentioned above. Remind students to note any changes if design is modified from the original sketch.

Design Brief

Field Trip Snack Holder

Third grade students are going on an end-of-year field trip. Each student is allowed to bring one snack item (an apple, string cheese, pudding cup, or juice box) which needs to be kept cold until snack time. Your team has been asked to design an individual, reusable snack holder that will keep their snack cold.

Criteria

(1) The snack holder must be large enough to contain the snack of the students' choosing.
(2) The snack holder must be reusable.
(3) The snack holder must maintain the snack at a desired temperature while placed in direct sunlight.

Constraints

(1) Materials available for construction
(2) Time

Assessment

The following are possible sources of formative and summative assessment:

- Design notebooks (individual) – Note how students identify and clearly label their drawings; Identify the types of science vocabulary students use in their notebooks (tally the number of times each concept is used); Note how students record data from testing their prototypes and how well they explain their results (patterns in the data).

- Presentation of design to class by the team. Provide positive design attributes, how design criteria where met, and possible redesigns.

- Participation (group) – Note level of engagement; questions students asked; how well they worked in a group; how well each team met the goals of the task.

- Other (individual and/or group) – Create a short pre and posttest that highlights key science vocabulary terms; Present a new situation or new problem on the same theme

- See Lesson Extension.

Other Resources

Useful Websites

http://en.wikipedia.org/wiki/Electromagnetic_radiation#History_of_discovery

http://www.brainpopjr.com/science/energy/light/grownups.weml

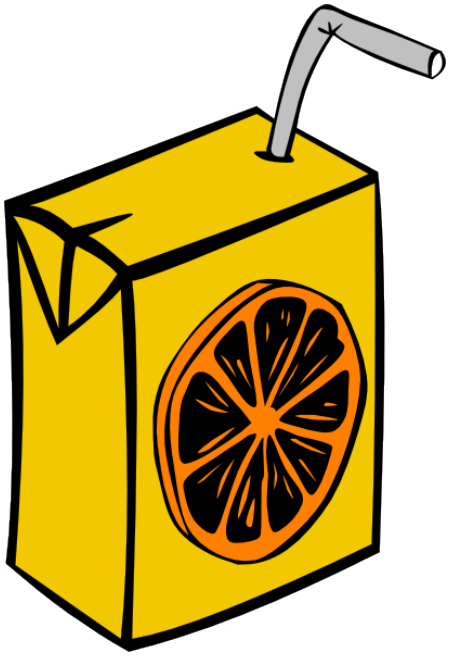
Appendix

The following pages contain the following:

1. Images of snack items that can be printed, cut out, and used in place of the real item.
2. Blank data table for Lesson Plan #1.
3. Blank Temperature (Fahrenheit) vs. time graph for Lesson Plan #1.
4. Blank Temperature (Celsius) vs. time graph for Lesson Plan #1.

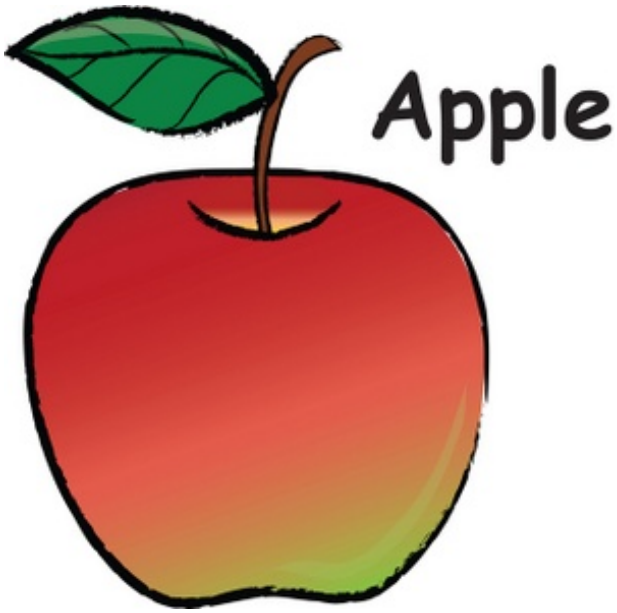
Images of Snack Items

http://www.clipartbest.com/clipart-9cpeGKgyi



http://c3e308.medialib.glogster.com/rj6277/media/43/43a5dd4352637e8777e92bf6a1df51062a39ba92/ccd329c208f14490b9be565d50403df7.jpg

http://www.clipartbest.com/clipart-pT5eBeKpc

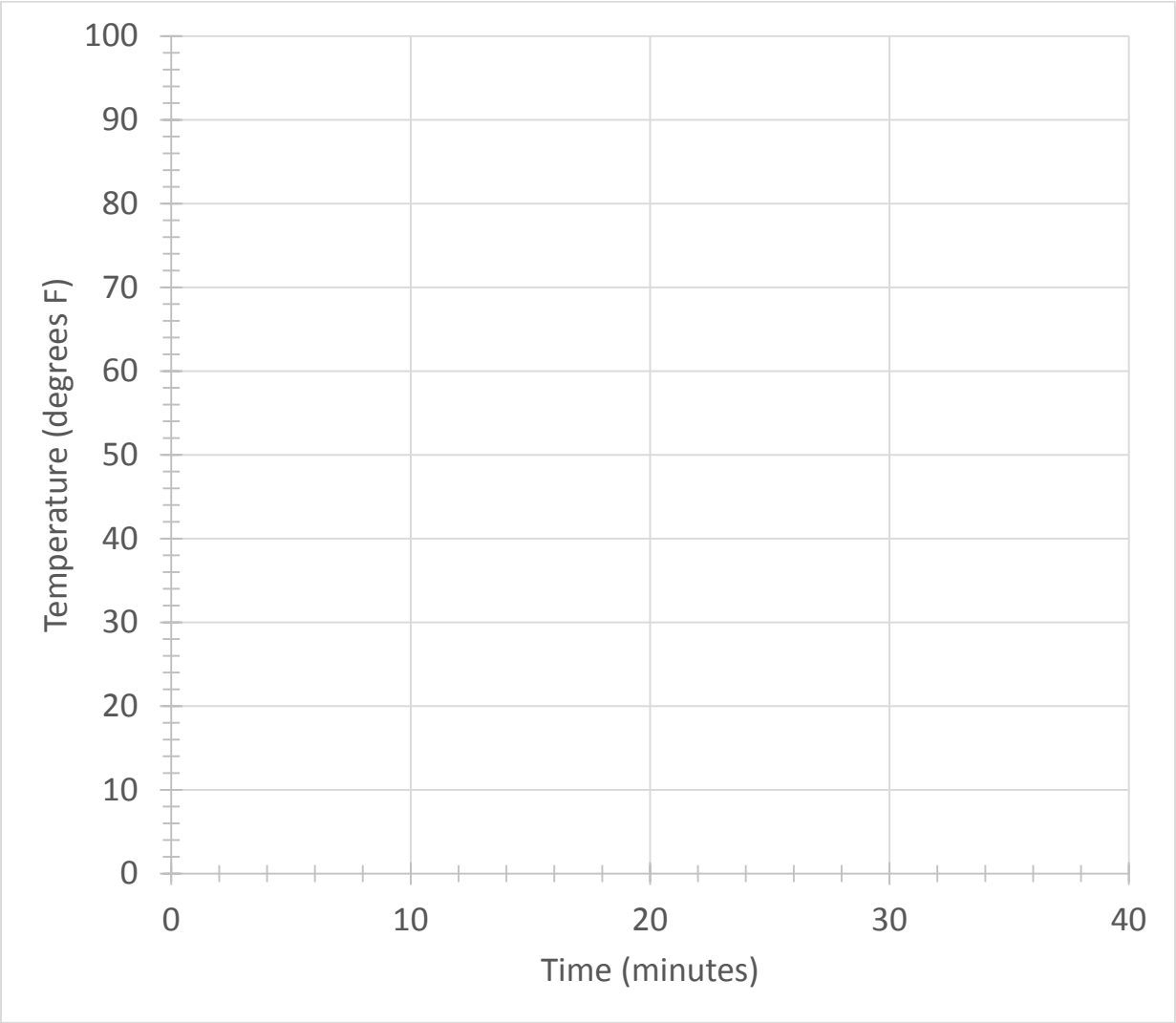


http://mountainviewmarket.coop/sites/default/files/09396654.png

Data Table

Materials	Temperature (°C) at Start (0 min)	Temperature (°C) at 5 min	Temperature (°C) at 10 min	Temperature (°C) at 15 min

Temperature (Fahrenheit) vs. Time Graph



Temperature (Celsius) vs. Time Graph