DRINK POUCH 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 drink pouch holder.

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.

Common Core Mathematics:

Common Core English and Language Arts:

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:

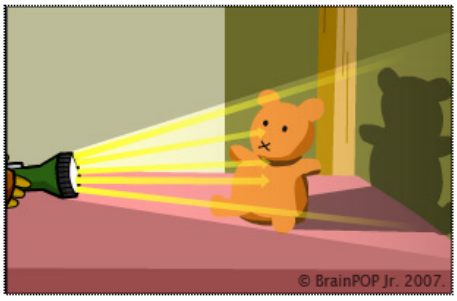
1. Cutting thick paper with scissors will be required.
2. If using the infra-red temperature meter, only the teacher should operate the meter or the teacher should closely supervise student operation of the meter because the meter contains a laser which can cause eye/vision damage (warning: avoid direct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

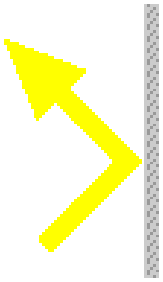
Light moves in straight lines.

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:	Drink box gets too warm and does not fit in car cup holder.
Goal:	Design a holder for a for a drink that will keep it cool when in the car.
Who is the client:	Child raising money for the zoo
End-User:	Students
What is the design:	Drink holder for kids drink.
Criteria:	1. Keeps drink cold. 2. Fits in drink holder. 3. Able to walk around with drink holder without breakage.
Constraints:	1. Materials available for construction. 2. Time. 3. Size of the holder.

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

Time: Three 30 minute class sessions

Procedure:

Introduction of Design Task

1. Introduce the drink pouch and/or drink box, cup holder and information on the client (Design Activity, Student Resource) by distributing the task to students.

2. **Ask:** What is the problem?
   Who is the client?
   Who is the end user?
   What are examples of constraints?

Prediction of Best Covering

1. Before students begin their plans, discuss important science principles that need to be understood in order to perform the design task. These are listed under the "Science Content" section.

   Ask: How does light heat up the drink?

2. In a class discussion, have the students determine which would be the best covering for the drink holder.

3. Provide an assortment of duct tapes for them to see (e.g., Silver, Reflective, White, Black, Multi-colors).

Test the Covering of the Drink Pouch Holder using a Test Coupon:

1. The students can choose the material they are going to use to cover their drink pouch holder.

2. A heavy piece of paper (e.g., oak tag) can be covered using their chosen tape. This is called a test coupon. Only one coupon is needed for each tape color. If students do not choose the black or white tape, create an additional test coupon for those tapes.

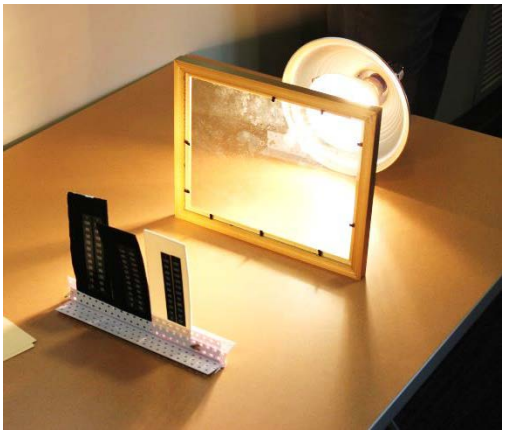
3. Apply a temperature label to the back of each test coupon and place in front of the lamp (see figure below).

4. Place a rectangle of glass or Plexiglas between the lamp and test coupon (i.e., an empty picture frame will work). This will simulate the car window; however, it also serves as an

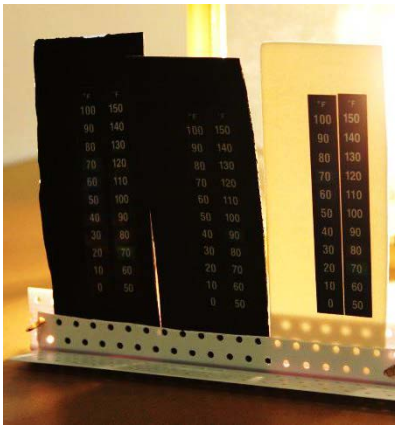
important testing requirement. The frame (i.e., window) will block most of the heat from the bulb filament, but allow the light energy to pass.

5. Have the students continue with the "Individual Design Brainstorming" section while the samples heat.

6. Check the samples after about 10 to 15 minutes. (Table provided after individual design)



Test Coupons and Lamp Set-up



Test Coupons and Adhesive Temperature Labels

Individual Design Brainstorming:

1. Have the students create an individual design. Ask:

   What size does the holder need to be?
   What shape should it be?
   Are you going to fold the paper or cut out the pieces?
   Where am I going to use the tape/covering?

2. Instruct students to sketch his/her possible designs for a drink pouch holder in their design books.

3. Check on the light test and record observations:

Sample Date Table	
Covering #1, Black Duct Tape	**°C**
Covering #2, Silver Duct Tape	**°C**
Covering #3, Reflective Duct Tape	**°C**
Covering #4, White Duct Tape	**°C**
Covering #5, Multicolor Duct Tape	**°C**

Team Design of the Drink Holder:

1. Have the team discuss the designs and provide a design based on the ideas. Ask:

   What are the important features of your design?
   How will you use some of the materials in your design?
   What are some challenges or problems you think your team may face?
   How could address these problems now?

2. Instruct each team to decide on one plan after they share their designs. The design could be a specific design of one student or a combination of designs.

3. Students will then construct one prototype per team. Allow 30 minutes for construction.

Testing of Team Design

1. Test each design using the following parameters:
   1. Will it stand by itself?
   2. Walk around with drink to see if it stays together (durable construction).

   Optional: Put an alcohol thermometer in a drink pouch and test in sunlight.

2. Go over the design of an actual drink pouch in the "Engineering of a Drink Pouch" section at the end of the lesson plan. This will provide a nice wrap up for how a drink pouch is designed.

Design Brief

Drink Pouch Holder

A third grader is going on a long trip in a car. She has a drink box, like the one shown below, but she has no place to put it because it doesn't fit well in the round cup holder. To make matters worse, the drink quickly heats up because it is in the sun.

To help fund the school trip to the zoo, she decides to make drink holders that can fit into cup holders in a car and that are made from a material that will not heat up too much in the sun. Can you help her design a drink box holder?

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

Activity Extensions:

An extension of this activity is to put a thermometer in the straw hole of a cold drink box. Put the drink box in the holder and let set in the sun for 30 minutes. Record the temperature change after 30 minutes to see what drink holder worked the best.

Useful Websites

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

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

Appendix – Teacher Background Science Content

Engineering of Drink Pouch

The design of a drink pouch consists of three important elements: geometry, material selection, and size (volume).

Geometry

The geometry of the pouch is an important consideration that helps to achieve to important functions:

1. The geometry help to reduce the space required to store or discard of empty pouches (i.e. pouches lay as a flat rectangle when empty)
2. The geometry allows the pouch to stand up when filled with fluid

The bottom is designed so that it can flare open once filled which allows the pouch to stand upright.

Material Properties

The most common type of drinking pouch is made with aluminum sandwiched between synthetic materials, namely polyester and polyethylene as shown in the figure below. The Capri Sun™ drink pouches are made this way. The following describes each material and their function:

- Synthetic materials – provides strength, stability, and are sanitary
- Aluminum – protects the contents from oxygen and light

The aluminum layer is extremely thin. One would have to stack approximately 125 sheets of this aluminum to create a stack that is about one millimeter thick.

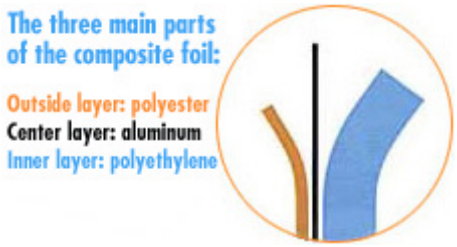


Figure 1. Magnified image showing the 3 layers that comprise Capri Sun drink pouches.

Size

Drink pouches are able to contain approximately 0.2 liters (200 milliliters). The empty pouch weights about 4.3 grams which is lighter than some types of a paper.

Once the design is determined for the drinking pouch, it has to be manufactured and filled with fluid. Drink pouches are mass produced in factories where they are opened, filled with product (i.e., juice), sealed and then packaged in boxes to be shipped out to customers.