Garden Biochemistry

Grade: *8* | ***Time:*** *(2-3) 60 minute periods*

Standards:

Georgia Performance Standards in Science
S8CS4.b, c; S8CS6.b, c; S9CS9.a, b, e; S8P1.b, d, e; S8P2.a, d
Next Generation Science Standards
PS1.A, PS1.B, PS3.A, PS3.B
Common Core Literacy Standards
ELACC6-8RST3, ELACC6-8RST4. ELACC6-8RST9

Supplies:

Salad

Harvest any leafy greens and veggies from garden

Pancakes

Bring Your Own
BYO: Pancake batter
BYO: Sautee Pan
BYO: Oil for cooking

Sorbet or Ice Cream Lab *(per student)*

- 1 gallon plastic bag
- 1 quart plastic bag
- Natural extract for flavoring

BYO milk (1 C per student) or Water
BYO 4 Tbsp salt per student
BYO fruit from the garden

I Second That Lab Emulsion *(per group)*

BYO: 2 mixing bowls
BYO: 2 wire whisks
BYO: 1 measuring cup and meas spoons
BYO: 1 egg yolk per team
BYO: 6 teaspoon vinegar per team
BYO; 2 cup vegetable oil per team
2 small cups for vinegar and oil
*See the lesson plan below for additional supplies.

Solar Cookers

Variety of materials may include:
BYO: Small boxes (1 per team)
BYO: Poster board
BYO: Clips, tape, glue, and scissors
BYO: Foil and plastic wrap
BYO: Newspaper or insulation
BYO: thermometer

Garden Connection:
Students will grow, prepare, and cook vegetables and fruits from the garden.

STEM Connection:
Students will engage in an engineering design challenge where they build a solar cooker

Overview

Students will explore compounds, mixtures, emulsions, states of matter, and physical and chemical changes using food harvested from the school garden. Students will also engage in an engineering design challenge where they build a solar garden cooker to demonstrate their understanding of heat transfer and insulation.

Essential Questions

How can I use food harvested from the garden to demonstrate and explain mixtures, compounds, and emulsions?
What is the difference between a chemical and a physical change?
What are examples of physical and chemical changes that take place involving food? How can heat convection, reflection, conduction and absorption be demonstrated in a solar cooker?

Engage

Students will harvest plants from the garden and demonstrate mixtures, physical and chemical changes.

Explore

Students will explore food chemistry and distinguish between physical and chemical changes by making sorbet or ice cream.

Explain

Students will be able to identify foods prepared from the garden as mixtures, compounds, or emulsions. Students will also be able to identify the physical or chemical changes that were part of food preparation of plants in the garden; and explain the methods of energy transfer from the perspective of cooking food (convection, conduction, and radiation). Students will explain the design and functionality of the solar cookers they engineered and distinguish between physically and chemically changing food by cooking or warming it.

Environmental Stewardship

Students will use knowledge of heat transfer to design an early spring seed starting area in the garden. Students will contribute the garden cooking device(s) or ovens they built for future use by younger gardeners.

Evaluate

A rubric is provided to assess student mastery of performance expectations

Extend

Students may make an emulsion, make a solar cooker as part of an engineering design challenge, or participate in online interactive simulations about physical and chemical change

Standards

GEORGIA PERFORMANCE STANDARDS IN SCIENCE

S8CS4. Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities utilizing safe laboratory procedures.

b. Use appropriate tools and units for measuring objects and/or substances.
c. Learn and use standard safety practices when conducting scientific investigations.

S8CS6. Students will communicate scientific ideas and activities clearly.

b. Write for scientific purposes incorporating information from a circle, bar, or line graph, data tables, diagrams, and symbols.
c. Organize scientific information in appropriate tables, charts, and graphs, and identify relationships they reveal.

S8CS9. Students will understand the features of the process of scientific inquiry.

Students will apply the following to inquiry learning practices:

a. Investigations are conducted for different reasons, which include exploring new phenomena, confirming previous results, testing how well a theory predicts, and comparing different theories. Scientific investigations usually involve collecting evidence, reasoning, devising hypotheses, and formulating explanations to make sense of collected evidence.
b. Scientific investigations usually involve collecting evidence, reasoning, devising hypotheses, and formulating explanations to make sense of collected evidence.

S8P1. Students will examine the scientific view of the nature of matter.

b. Describe the difference between pure substances (elements and compounds) and mixtures.
d. Distinguish between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
e. Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).

S8P2. Students will be familiar with the forms and transformations of energy.

a. Explain energy transformation in terms of the Law of Conservation of Energy.
d. Describe how heat can be transferred through matter by the collisions of atoms (conduction) or through space (radiation). In a liquid or gas, currents will facilitate the transfer of heat (convection)

NEXT GENERATION SCIENCE STANDARDS

PS1.A: Structure and Properties of Matter
Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2), (MS-PS1-3)

PS1.A: Structure and Properties of Matter
The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)

PS1.B: CHEMICAL REACTIONS
Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2), (MS-PS1-3), (MS-PS1-5)

The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)

Some chemical reactions release energy, others store energy. (MS-PS1-6)

NEXT GENERATION SCIENCE STANDARDS

PS3.A: Definitions of Energy

The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to energy transferred due to the temperature difference between two objects. (Secondary to MS-PS1-4)
Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2), (MS-PS1-3)

The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (Secondary to MS-PS1-4)

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, the environment. (MS-PS3-4)
Energy is spontaneously transferred out of hotter regions or objects into colder ones. (MS-PS3-3)

COMMON CORE LITERACY STANDARDS

ELACC6-8RST3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

ELACC6-8RST4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

ELACC6-8RST9: Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic

Teacher Background Information

Elements, Compounds, Mixtures, and Emulsions

- When dealing with materials, chemists typically classify things as being elements, compounds, or mixtures.
- **Elements** are defined as substances that cannot be chemically decomposed into simpler substances. For example, gold is an element, as are all of the substances on the periodic table. If you have a block of gold, you can do a lot of things to it—melt it, dent it, and so forth. One thing you can't do, however, is break the gold atoms down into simpler materials. As an element, the gold atoms are, for our purposes, indestructible.
- **Chemical compounds** are materials which consist of elements bonded to one another in defined proportions. For example, when we talk about water, we're always talking about H2O. Water never has the formula H4O or anything else—no matter what, it always has two atoms of hydrogen and one atom of oxygen. Because it always has the proportion of 2 H to 1 O, and because the hydrogen and oxygen atoms are chemically bonded to one another, water is a chemical compound. Unlike an element, a compound can be broken down into simpler materials through the use of chemical reactions. For example, through a process known as electrolysis, water can be broken down into hydrogen gas (H2) and oxygen gas (O2).
- **Mixtures** are materials that contain more than one type of element or compound. One example of a mixture is salt water—because it contains both water (H2O) and salt (NaCl), it's a mixture. Though there are a lot of different mixtures, the classification of mixtures can be broken down further to include two different subcategories: homogeneous mixtures and heterogeneous mixtures.

- **Homogeneous mixtures** are mixtures in which the components are completely and evenly mixed with one another. An example of this is salt water. If you take a small portion of salt water from one side of a glass and another small portion of salt water from the other side of the glass, both will have identical ratios of salt to water. Other homogeneous mixtures you may be familiar with include air (where various gases are evenly mixed with one another), fruit punch (where sugar and various other compounds have been dissolved in water), and stainless steel (in which iron and various other elements are entirely mixed with each other).

- **Heterogeneous mixtures** are unevenly combined mixtures. If you take one sample of a heterogeneous mixture and another sample from a different part of the mixture, the two won't be identical to one another. For example, if you were to take several samples from chunky peanut butter, in one you might find a brown paste and in another you might find a hunk of peanut. Frequently, you can tell a heterogeneous mixture from a homogeneous mixture because you can see that they contain different components.

- Somewhere between homogeneous and heterogeneous mixtures lie the colloids. **Colloids** are heterogeneous mixtures which appear completely uniform in composition, but really just have one type of particle suspended in another without having been dissolved. How does this happen? Well, imagine that you have placed some very, very tiny particles of solid into water. If these particles are small enough, the water molecules that are in the liquid will hit them from all directions, keeping them from falling to the bottom of the container. Though the particles may be heavier than water, these collisions with the water molecules keep them from sinking.

- Depending on what type of materials you have, there are several types of colloids:
  - Aerosols are formed when liquid or solid particles are suspended in a gas. Cigarette smoke is an example.
  - Foams are formed when gases are suspended in a liquid or solid. An example of a foam is whipped cream.
  - Emulsions are formed when particles of one liquid are suspended in another. Butter and mayo are emulsions.
  - Sols occur when solid particles are suspended in a liquid. Blood is a sol.

- The best way to tell a colloid from a solution is to shine light on it. If the material seems cloudy, it's a colloid, and if it's clear, it's a solution. This technique is exploited in horror movies where a minor character shines a light into a smoky room.

- *For more information about elements, compounds, mixtures, and emulsions, see the websites below:*
  - https://www.teachengineering.org/view_lesson.php?url=collection/uoh_/lessons/uoh_sep_mixtures_less1/uoh_sep_mixtures_less1.xml
  - http://www.chemistrytutorials.org/content/matters-and-properties-of-matters/1-classification-of-matters
  - http://www.scienceclarified.com/everyday/Real-Life-Chemistry-Vol-2/Mixtures-Real-life-applications.html
  - http://anatomyandphysiologyi.com/molecules-and-compounds/
  - http://www.ivyroses.com/Chemistry/GCSE/Elements-Mixtures-Compounds.php
  - http://www.pickerington.k12.oh.us/docs/olc/newsdocs/Elements-Mixtures-Compounds%20Notes%20-1.pdf

Chemical and Physical Changes

- A **chemical change** is any change that results in the formation of new chemical substances. At the molecular level, chemical change involves making or breaking of bonds between atoms. During this breaking and making of bonds there is difference in energy. If the energy required to break the bonds is greater than the energy required to make the bonds, then the energy is given out to the surroundings.

- Some **indicators of chemical reactions** include color change, heat given off, two liquids combining to form a solid precipitate, or a gas (bubbles) produced.

- These changes are chemical:
  - iron rusting (iron oxide forms)
  - gasoline burning (water vapor and carbon dioxide form)
  - eggs cooking (fluid protein molecules uncoil and crosslink to form a network)
  - bread rising (yeast converts carbohydrates into carbon dioxide gas)
  - milk souring (sour-tasting lactic acid is produced)
  - sun tanning (vitamin D and melanin is produced)

- **Physical change** rearranges molecules but doesn't affect their internal structures. Phase changes (such as water going from liquid to frozen state) are physical changes because no new substance is formed: it's still H20. Some examples of physical changes are:
  - » whipping egg whites (air is forced into the fluid, but no new substance is produced)
  - » magnetizing a compass needle (there is realignment of groups ("domains") of iron atoms, but no real change within the iron atoms themselves).
  - » boiling water (water molecules are forced away from each other when the liquid changes to vapor, but the molecules are still H2O.)
  - » dissolving sugar in water (sugar molecules are dispersed in water, but individual sugar molecules are unchanged.)
  - » dicing potatoes (cutting usually separates molecules without changing them.
- *For more information about physical and chemical changes, see the websites below:*
  - » http://www.chemteam.info/Matter/PhysicalChemChanges.html
  - » https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/introduction-to-chemistry-1/physical-and-chemical-properties-of-matter-28/physical-and-chemical-changes-to-matter-182-1380/
  - » http://www.ge.com/press/scienceworkshop/docs/pdf/ChemicalvsPhysical_Change_with_Standards.pdf

States of Matter

- Matter is a term used for everything having mass and volume. In physics, a state of matter is one of the distinct forms that matter takes on. Four states of matter are observable in everyday life: solid, liquid, gas, and plasma. Many other states are known such as Bose–Einstein condensates and neutron-degenerate matter but these only occur in extreme situations such as ultra-cold or ultra-dense matter.
- The distinction of the states of matter is based on qualitative differences in properties, specifically the density of particles. Matter in the solid state maintains a fixed volume and shape, with component particles (atoms, molecules or ions) close together and fixed into place. Matter in the liquid state maintains a fixed volume, but has a variable shape that adapts to fit its container. Its particles are still close together but move freely. Matter in the gaseous state has both variable volume and shape, adapting both to fit its container. Its particles are neither close together nor fixed in place. Matter in the plasma state has variable volume and shape, but as well as neutral atoms, it contains a significant number of ions and electrons, both of which can move around freely. Plasma is the most common form of visible matter in the universe.
- "**Phase" describes a physical state of matter**. The key word to notice is physical. Things only move from one phase to another by physical means. If energy is added (like increasing the temperature) or if energy is taken away (like freezing something), you have created a physical change. When molecules move from one phase to another they are still the same substance. There is water vapor above a pot of boiling water. That vapor (or gas) can condense and become a drop of water in the cooler air. If you put that liquid drop in the freezer, it would become a solid piece of ice. No matter what physical state it was in, it was always water. It always had the same chemical properties.
- On the other hand, a **chemical change** would build or break the chemical bonds in the water molecules. If you added a carbon (C) atom, you would have formaldehyde (H2CO). If you added an oxygen (O) atom, you would create hydrogen peroxide (H2O2). Neither new compound is anything like the original water molecule. Generally, changes in the physical state do not lead to any chemical change in molecules.
- *For more information about the states of matter, see the websites below:*
  - » http://www.livescience.com/46506-states-of-matter.html
  - » http://www.chem.purdue.edu/gchelp/atoms/states.html
  - » http://idahoptv.org/sciencetrek/topics/matter/facts.cfm
  - » http://www.krysstal.com/states.html
  - » http://www.grc.nasa.gov/WWW/k-12/airplane/state.html

Law of Conservation of Energy

- Energy can be defined as the capacity for doing work. It may exist in a variety of forms and may be transferred from one type of energy to another. However, "Energy can neither be created nor destroyed." Another approach is to say that the total energy of an isolated system remains constant. Energy can be converted from one form to another (potential energy can be converted to kinetic energy) but the total energy within the domain remains fixed

Engage

Have students harvest plants from the garden for food chemistry demonstrations.
Set up the following stations where students can explore food chemistry:

1. Homogenous Mixture: Sun Tea
   Make sun tea by infusing mint from the garden (or oranges, tea bags, etc). in water and letting it get warm in the sun. Then remove the infuser and stir. Tea is homogeonous because every sip has the same proportion of ingredients, once mixed. If sugar is added, the sugar must be hot enough to dissolve in the water for it to become a homogenous mixture.

2. Heterogenous Mixture: Salad
   Harvest vegetables and fruits from the garden to make a salad, as an example of a heterogenous mixture. It is heterogenous because no matter how well mixed, one section of the salad does not have identical proportion of ingredients to those in another section of the salad. Let students count the ingredients in their servings and compare.

3. Physical Change from Solid to Liquid: Melted Ice Cube
   Melt an ice cube. Whether solid or liquid, every molecule is still the same proportion of two hydrogen atoms and one oxygen atom: water.

4. Chemical Change: Pancakes
   Bite an apple and let the uneaten part sit in the sun. The browning is a chemical change as the apple oxidizes. Or demonstrate how a new substance is formed when pancake batter is cooked.

Explore

Physical Change from Liquid to Solid: Ice Cream or Sorbet in a Bag

1. Harvest strawberries or other fruit from the garden.
2. Mix 1 cup of Milk, 1 Tablespoons of sugar and 1/4 teaspoon vanilla or almond extract in a small zip bag. Add mashed fruit. Or just mix fruit and water in a blender and pour 1 cup into a small bag.
3. Expel all of the air from the small bag, seal it, and gently mix the ingredients by massaging.
4. In a larger plastic bag, place two cups ice and approximately 4 tablespoons of salt.
5. Place the small bag into the large bag; expel air from the large bag and seal.
6. Shake the bags vigorously until the ingredients are frozen to custard ice cream consistency (10 minutes).
7. Open the large bag, wipe salt off the smaller bag, cut a bottom corner off the small bag with scissors and eat from it. (Or place ice cream/ sorbet in paper cups and eat with a spoon)

Explanation form Evidence

Students will be able to identify mixtures, compounds, and emulsions made from foods harvested from the garden.
Students will be able to identify the physical or chemical changes that were part of food preparation of plants in the garden.
Students will explain the methods of energy transfer during cooking as convection, conduction, or radiation.
Students will be able to explain the design and functionality of the solar cookers they engineered.

Environmental Stewardship

Students will use knowledge of heat transfer to design an early spring seed starting area in the garden.
Students may also donate the solar cooker for use by younger students in the garden.

Evaluate

A rubric is provided to ass student mastery of performance expectations.

Use the following examples to elicit student understanding of physical vs chemical changes. Ask students to describe the "rule od thumb" or reasoning used to distinguish between physical (reversible) and chemical (not reversible) changes.

Sanding Wood	Scrambling Eggs	Juicing Oranges
Toasting Bread	Melting Butter	Breaking Glass
Rusting Nail	Spoiled Milk	Boiling Water
Bleaching Hair	Burning Paper	Melting Ice

Answers: *Physical changes: sanding wood, melting butter, breaking glass, boiling water, juicing oranges, and melting ice cream. Chemical changes: toasting bread, scrambling eggs, rusting nail, spoiled milk, bleaching hair, burning paper. A chemical change is any change that results in the formation of new chemical substances. The starting materials change into an entirely different substance or substances. At the molecular level, a chemical change involves making or breaking bonds between atoms (irreversible). With a physical change, the substance change form, but keeps its same chemical composition (reversible).*

Extend

1. Make an Emulsion

"I Second that Emulsion" from http://www.ift.org/~/media/Knowledge%20Center/Learn%20Food%20Science/Food%20Science%20Activity%20Guide/activity_isecondthatemulsion.pdf; written by Jeremy Peacock and Amy Rowley

PLEASE NOTE: *The emulsion prepared in this demonstration is made with raw eggs and should not be consumed unless they are pasteurized. Raw eggs may contain Salmonella, a bacterium which can cause foodborne illness.*

Oil and water don't mix! You've heard it a thousand times. But an emulsion is a colloid: a mixture of very tiny particles that are dispersed in another substance, which do not settle out of that substance even though they normally would separate. Emulsifying is done by slowly adding one ingredient to another while simultaneously mixing. This disperses and suspends tiny droplets of one liquid (known as the dispersed phase) through another (known as the continuous phase). To prevent the mixture from separating, an ingredient, known as an emulsifier, which is attracted to both oil and water, is added, thus allowing the two to mix.

Materials and Equipment: *2 mixing bowls, 2 wire whisks, 1 measuring cup, measuring spoons, 1 egg yolk, 6 teaspoon vinegar, 2 cup vegetable oil, 2 5-oz. plastic sample cups (for vinegar and oil).*

Demonstration Instructions:

- **No emulsifier (experiment 1):**
  1. Add 1 tsp. vinegar to a mixing bowl.
  2. Add oil, 1 tbsp. at a time, while continuously beating the mixture, until 1/3 cup is added.
  3. Add 1 tsp. of vinegar and continue to beat mixture.
  4. Repeat steps 2 and 3 until all liquids have been added.
- **Emulsifier (experiment 2):**
  1. Add egg yolk and 1 tsp. vinegar to a mixing bowl.
  2. Beat vigorously until slightly thick.
  3. Add oil, 1 tbsp. at a time, while continuously beating the mixture, until 1/3 cup is added.
  4. Add 1 tsp. of vinegar and continue to beat mixture.
  5. Repeat steps 2 and 3 until all liquids have been added.

NOTE: The emulsion will not form unless the oil is added VERY slowly

Student questions:

» Observe the appearance, texture, and aroma of the mixtures and record them in your science notebook.

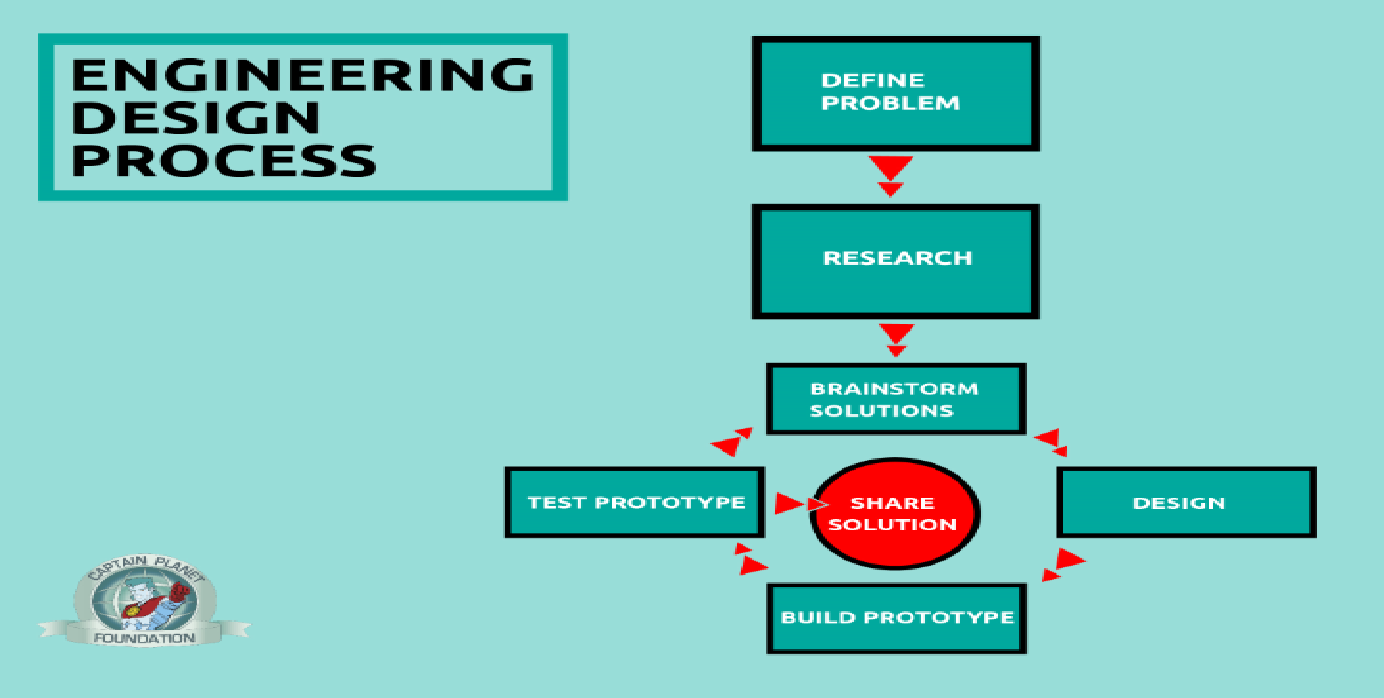
» Compare and contrast the results from both experiment 1 and experiment 2. How could you explain why these similarities or differences have occurred? (the emulsifier enabled a colloid to form)

» What common food emulsion did you prepare? (mayonnaise, an oil in vinegar emulsion)

» Lecithin is the emulsifier in this emulsion. Which ingredient used in this recipe contains lecithin? (egg yolk)

2. Make a Solar Cooker

Engage students in the Engineering Design Process to build solar ovens. Divide students into teams and explain the engineering design process (see diagram). Provide a variety of materials ranging from cardboard boxes and poster board to foil, newspaper, plastic wrap, tape, glue, and thermometers. Encourage each team to be creative in their design and to rely on their knowledge of heat transfer methods and insulation to make a solar cooker, rather than copying any particular design they might have seen.



Problem: Build a Solar Cooker that will cook a designated item from the garden in a set time

Specifications and Constraints

1. It must have a "footprint" of no more than 40 cm x 40 cm.
2. The temperature inside the box must increase by 10 oC in the shortest time.
3. You may use any available materials to line the bottom and inside of box.
4. Highest temperature reached in set time is best result

Pre-lab activities:

- ◊ Show students pictures of solar cookers used around the world. Additionally, inform students about statistics illustrating the use of solar ovens and solar energy throughout the world, specifically in developing nations. See examples at http://www.solarcooking.org . »
  and **"Build a Solar Oven"** from http://www.nasa.gov/pdf/435855main_BuildaSolarOven_6to8.pdf written by NASA contributors.
- ◊ Discuss how heat transfer concepts are used to make the oven work. The oven needs to concentrate solar radiation on the center of the oven. The pot or pan must absorb as much solar radiation as possible. Then, the rest of the oven must be designed to resist heat transfer through conduction by insulating the oven.

Brainstorm Ideas for Solar Cooker Design

Sketch a Design for the Solar Cooker

Build the Prototype taking into account the specifications

Test the Prototype and ReDesign

- Cook something in the solar cooker and see how much the temperature can increase in a set amount of time.
- Redesign the solar cooker and rebuild it. Test again for improvement.

Student Extension Videos

- *"Elements, Compounds and Mixtures"* - http://www.discovery.com/tv-shows/other-shows/videos/assignment-discovery-shorts-elements-compounds-and-mixtures/ (2:08)
- *"Atoms, Elements, Compounds, and Mixtures Explained"* - https://www.youtube.com/watch?v=gr-3j9tOJqM (5:05)
- *"Understanding Atoms, Elements, and Molecules Part #1"* - https://www.youtube.com/watch?v=cV4jJZCIMPo&index=3&list=PLAD1E2E66D9D6A8A6 (9:39)
- *"Physical and Chemical Changes of Matter"* - http://studyjams.scholastic.com/studyjams/jams/science/matter/changes-of-matter.htm (3:00)
- *"Physical and Chemical Changes"* - http://www.bozemanscience.com/physical-chemical-changes/ (11:07)
- *"Exploring Chemical vs. Physical Changes in Science"* - https://www.teachingchannel.org/videos/teaching-physical-and-chemical-changes (8:43)
- *"States of Matter"* - https://www.brainpop.com/science/matterandchemistry/statesofmatter/ (4:26)
- *"States of Matter"* - https://www.khanacademy.org/science/chemistry/states-of-matter/v/states-of-matter (19:23)
- *"Solids, Liquids, and Gases"* – http://studyjams.scholastic.com/studyjams/jams/science/matter/solids-liquids-gases.htm (3:20)
- *Various states of matter videos:* http://www.neok12.com/States-of-Matter.htm
- "*Heat Transfer: Conduction, Radiation, and Convection*" https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer--conduction--convection--radiation
- *"First Law of Thermodynamics: Law of Conservation of Energy"* - http://education-portal.com/academy/lesson/first-law-of-thermodynamics-law-of-conservation-of-energy.html#lesson (7:34)

Extension Simulations and Interactions

- Physical and Chemical Changes:
  - » http://www.glencoe.com/sites/common_assets/science/virtual_labs/E03/E03.html
  - » http://www.learnalberta.ca/content/secsu/html/matter_and_chemical_change/ChemicalAndPhysicalChange/
- States of Matter:
  - » http://www.harcourtschool.com/activity/states_of_matter/
  - » http://phet.colorado.edu/en/simulation/states-of-matter
  - » http://www.sciencekids.co.nz/gamesactivities/detectivescience/statesofmatter.html
  - » http://www.pbs.org/wgbh/nova/physics/states-of-matter.html
  - » http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks3/science/changing_matter/index.htm
  - » http://www.media.pearson.com.au/schools/cw/au_sch_linstead_sa1_1/dnd/05_state.html
- Elements, Compounds, and Mixtures:
  - » http://mint.ua.edu/games/chemical-mixup/

Garden Biochemistry

***Grade:** 8 | **Time:** (2-4) 60 minute periods*

Name: ______________________ ***Date:*** ________________________ ***Teacher:*** ________________________

Level of Mastery Benchmark or Performance Measure	 **EMERGING** **Not yet proficient** **1 point**	 **COMPETENT** **Partially proficient** **4 points**	 **PROFICIENT** **Mastered task** **5 points**	**TOTAL POINTS**
Cooking and Food Preparation Experiments	Student can distinguish between physical and chemical change but cannot say why.	Student can distinguish between physical and chemical change and identifies some rules of thumb. Student can also distinguish between homogenous and hetereogenous mixture.	Student can distinguish between physical and chemical change and identifies some rules of thumb and knows that physical changes are reversible but chemical reactions are (usually) not. Student can also distinguish between homogenous and hetereogenous mixture.	
Engineering Design Challenge	Students needed lots of teacher input. Little if any independent brainstorming. Most team members were often off task and not cooperating or participating fully. Team brainstormed few design ideas and did little testing or redesigning. Final design lacks clear design idea(s). Team gave a weak presentation of its solution to the challenge and showed little understanding of the science concepts and design process.	Students needed some teacher direction brainstorm possible solutions. Some team members were occasionally off task. Team gave a basic presentation of its solution to the challenge and showed basic understanding of the science concepts and design process.	Student independently brainstormed solutions and also worked well together with team members. All team members participated and stayed on task. Team brainstormed many design ideas and tested and improved the design. Re-design complete or nearly complete and shows creative problem solving. Team gave a strong presentation of its solution to the challenge and showed clear understanding of the science concepts and design process.	