I. Identification	
Lesson title:	**A Cosmic Cafeteria**
Teaching unit:	**Space Agriculture in the Classroom**
Lesson number in this unit:	**5 of 7**
Module Correlation:	***Growing Space, Volume 2* (pp. 8-9)**
National Standards:	**Science: A, B, D, E, F** **Math: Algebra, Measurement, Data Analysis, Connections, Representation** **Language Arts: 1, 3, 4, 7, 11, 12**

II. Specific Instructional Objective(s)

Students will be able to:

1. **Differentiate between transit and surface food systems *(Analysis domain)*.**
2. **Measure energy released by different foods**
3. **Compare and contrast cooking with solar energy here on earth and what they have learned about cooking on mars**

III. Equipment, materials, supplies, books, resources needed for this lesson (attach handouts):

- Balance (accessible to each group)
- Beaker (500 ml, for demonstration)
- Bromthymol blue (2% solution)
- Candle (for demonstration)
- Cellophane tape (per group)
- "Chunky" soup can (1 per group)
- Concentrated juice can (1 per group)
- Cork (1 per group)
- Culture dish or petri dish (for demonstration)
- Graduated cylinder (100 ml, 1 per group)
- Matches (per group)
- Nails (iron, 2 per group)
- Paper clip (1 large per group)
- Paper toweling or hot pads (per group)
- Thermometer or temperature probe (1 per group)
- Water
- Pizza box
- Ruler
- Marker or pen

- Scissors
- Plastic wrap (plastic for covering windows will work)
- Aluminum foil
- Tape or glue (non-toxic)
- Drinking straw or stick
- A sunny day
- Paper plate or napkins
- Either hot dogs, buns or bread For Hotdogs OR graham crackers, marshmallows, chocolate bar For S'mores

IV. Teaching Model: Concept Attainment (Joyce, Weil, & Calhoun, 2004)	
Set/Interest approach (suggested):	Teacher: "Consider all of the items that you and your family members might pack if you were going on a two-week summer vacation. Would you and your brother or sister argue over who sits next to the window or who is allowed to bring the most DVDs for the ride? How many pairs of shoes would you need to leave behind? Would you be "forced" to wear the same shirt more than once? What about food? Would your family take turns deciding who gets to choose the next fast food restaurant, or would you all select a special treat to carry with you from your local supermarket? "What if there were not so many conveniences available to you on every corner? Would you be upset if you were allowed to take only one suitcase? Would you throw a tantrum if you could not take all of your toys <u>and</u> your handheld video games? "The truth is there was a time when traveling was much more difficult, and travelers had to be very particular about the items they took with them. Too many "extras" (like clothes and toys) meant that a family could starve and die before reaching its ultimate destination because they would not have enough room for their food supplies. There

	was not much room for a variety of tastes, either. It is true! There was a time when you could not "have it your way!" "While we may pack sodas, bottled water, chips, and Oreo cookies on a car trip, the variety and convenience foods were not as plentiful for the pioneers. Yeast for baking, crackers, cornmeal, bacon, eggs, dried meat, potatoes, rice, beans, and a big barrel of water are examples of the limited food items that pioneers could carry in the limited space of their covered wagons as they began their trip to new settlements in the west. For very special occasions, some might even take along some chocolate. They might also take a cow or oxen if they owned these, using them for milk and meat. Pioneers made their own clothing, so they needed cloth to sew, needles, thread, pins, scissors, and leather to fix worn-out shoes. They had to make their own repairs so they also needed saws, hammers, axes, nails, string, and knives. "These food supplies had to last them for an indefinite amount of time, since they were never exactly sure how far they would or could go, or if they would encounter detours that delayed them along the way. This is somewhat true for space travel today! While we are much more certain of how far we have to go and how much time it will take to get to Mars, we are still faced with the same dilemma of early pioneers: we have to carry our food with us until we can arrive and produce our own food!"
Stated objective(s) (suggested):	By the end of this lesson, we will be able to differentiate between transit and surface food systems, measure energy released by different foods, and use solar energy to cook like the people on space station do.
Purpose (suggested):	It is important to consider how different types of food affect astronauts, the calorie intake that they have, and how they cook their food

	when they are traveling through space.
Presentation: **Objective 1** • **Engage students in reading pp 8-9 of the reading module ("A Cosmic Cafeteria")** • **Read out loud the definitions of "transit food system" and "surface food system" from the glossary.**	**Teaching methods** • **Method is teacher's choice – aloud (only if student ability supports this method), silently, in reading support groups, and others.** • **As students read, encourage them to use the glossary in the back of the module (pp. 14-15).** • **Teacher should write vocabulary words on the board and say them for the students** • **Divide students into groups of four.** • **Students should then be divided into two teams, one is the transit food system, and the other is the surface food system. Have students determine three facts about their type of food system, and then share with the other two in their group. (Think, Pair, Share)**
Check for understanding: Objective 1	• **Have each group create a poster about the two food systems, and present it to the class.**
Objective 2 • **"Counting Calories" Experiment** • **Teacher background information attached** • **Source:** http://www.michigan.gov/printerFriendly/0,1687,7-155--43904--,00.html • **TEACHER'S NOTE: Due to variation in class schedules, be sure to conduct this experiment before presenting to students. It is safer if you, the teacher, conduct this experiment for the students instead of letting them do it**	• **"We know from the reading that a person in space needs to consume the same amount of calories as a person on earth. The more food that we eat, the more energy that we have. Calories are not always good, but we need them for our energy."** • **"What can the astronauts do to make sure that they have enough energy to work everyday?"** • **They can Count Their Calories** • **See attached instructions for printable version of Counting Calories Experiment.**

themselves. The experiment uses fire.	
Check for understanding: Objective 2	• **Students should complete counting calories worksheet** • **Attached Data Analysis worksheet for Counting Calories Experiment**
Objective 3 • **Cooking with the Sun (The oven can already be made before the class)** • **Students can construct individual solar ovens, work in pairs, or create a class solar oven.** ***Individual or pair construction is optimal*** • **For Pictures of the Construction of the ovens refer to the Teacher Resources at the end of the lesson** • **TEACHER'S NOTE: Due to variation in class schedules, be sure to conduct this experiment before presenting to students. Cooking hot dogs will probably take more time than the S'mores.**	• **Cooking with the Sun Instructions:** • **Draw a square on top of the pizza box. Make it one inch away from the edges.** • **Cut along three sides. Do not cut the line along the back of the box.** • **Make a flap by folding back along the uncut line.** • **Cut a piece of foil to fit the inside of the flap.** • **Glue or tape the foil in place, shiny side out. If you put it on carefully, it will not wrinkle much.** • **Press out any wrinkles with your fingers.** • **Cut the plastic to fit over the hole that the flap made. Make sure the plastic is much bigger than the hole.** • **Tape the plastic to the box. Seal the plastic tightly so that the air cannot get out.** • **Cut another piece of foil to cover the bottom and sides of the box.** • **Glue or tape the foil into place** • **Cover the foil with black construction paper, and tape it into place.** • **Put your solar oven in a flat sunny spot.** • **Open the solar oven** • **Lay a piece of foil in the center of the box. You can also use a napkin or paper plate.** • **For hot dogs put the hot dogs on the foil.** • **For S'mores, put a cracker and**

	marshmallow on the foil. • Close the box. • Open the flap of the box. • Prop the flap open with the drinking straw or stick. • Turn the flap towards the sun. You want the sun to reflect off of the foil and into the box. • Turn the box when you need to so that the flap is always facing the sun. As the Earth turns, or rotates, the sun is in a different place in the sky. • Let the hot dogs cook until they are ready. It may take 30 minutes to an hour before you can eat your hotdog! • Let the S'mores cook until the marshmallow melts. Add chocolate and another graham cracker. • Be careful. The oven can get very hot. • take the food out of the oven for you
Objective 4	
Closure (suggested):	**Journaling exercise: Have students write about what they learned about counting calories, and cooking using solar heat.**
Independent practice (suggested):	• **Based on counting calories, the students should keep track of the calories they intake for the next 24 hours, by looking on nutrition labels.**

V. Extension/Quest activities (optional, if time permits):

VI. Assessment

Teacher Determined

VII. Teacher Resources

Counting Calories Instructions:
http://www.michigan.gov/printerFriendly/0,1687,7-155--43904--,00.html

Cooking with the Sun Instructions:
http://www.nasa.gov/audience/forkids/activities/A_Cooking_with_the_Sun.html

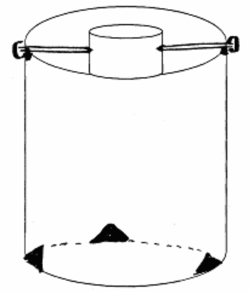
Counting Calories

Materials:

Balance (accessible to each group)
Beaker (500 ml, for demonstration)
Bromthymol blue (2% solution)
Candle (for demonstration)
Cellophane tape (per group)
"Chunky" soup can (1 per group)
Concentrated juice can (1 per group)
Cork (1 per group)
Culture dish or petri dish (for demonstration)
Graduated cylinder (100 ml, 1 per group)
Matches (per group)
Nails (iron, 2 per group)
Paper clip (1 large per group)
Paper toweling or hot pads (per group)
Thermometer or temperature probe (1 per group)
Water

Preparation:

Cut and puncture the cans as shown below prior to class. They can be saved and used indefinitely. Remove the tops from all cans. Remove the bottoms from the large cans. Remove all of the sharp edges. Using a can opener, make three triangular holes for ventilation in the bottom of the larger cans and two tiny notches on top to cradle the nails holding the smaller can. Put iron nails in either side of the smaller can as follows:



Safety Precautions:

The cutting of the cans should be done by the teacher prior to class. Use heavy work gloves and good safety procedures to avoid being cut. Watch for sharp edges on the cans. Control use of matches in the classroom. The cans can get very hot. Warn students not to touch the cans without covering them with paper towel.

1. If it is cold out, use that to your advantage. Begin the discussion by asking students to describe how to get warm. If the weather is warm, create an imaginary scenario. ("You are camping. A cool wind comes up…") Ask: "How do you get warm?" [Two lines of answers will probably emerge; "Move around a lot" and "Burn something."] An alternative opener might involve an imaginary machine; "Where will we get the energy to make the machine go?" [Fuel.] "What do we do with fuel?" [Burn it.]

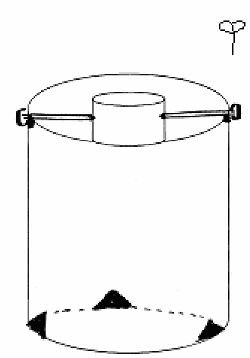
2. Light a candle. Put your hand a little close (not recklessly close!) Ask: "Where does the heat come from?" [There are two possible answers: from the burning wick and from the burning wax. Actually, both are happening.]

3. Place the candle on the bottom of the glass Petri dish or culture dish. (Putting it on the plate of your overhead projector helps with visibility. Use a little bit of wax to secure the base.) Gently, pour bromthymol blue around the base. [Don't get water on the projector!] Invert the 500 ml beaker over the candle gently. [Before the candle goes out, the increase in CO_2 in the beaker will change the color of the BTB.] Ask students:

   "What is bromthymol blue?" [Indicator]"What does the change in color show?" [CO_2 production]"What other process is like the burning candle?" [Organisms using energy—refer students to Lesson 2]

4. Remind students that food is fuel for the body. Ask them: "How do you think your body gets energy out of food?" If a student speculates, "It burns it" ask for evidence. Ask students to write a sentence on the Student Page that begins, "Burning a candle is like burning food because…" […produces heat, produces energy, uses O_2, and produces CO_2]

5. Tell students that together you are going to explore how much energy is contained in several foods. Ask them to assemble the two cans shown above. The paper clip must be bent out to form a little "platform" like this and stuck in a cork:



6. Have students wrap the larger can in several layers of paper towel (taped to itself), so that it can be moved without burning hands. But remind them not to block the air holes. Ask why this is important. [Air is needed for burning.]

7. Have students put exactly 100 ml of water in the juice can with nails set into the holes. Set aside.

8. Have students carefully mass a small piece of food. Record the name of the food and the starting mass on the data sheet.

9. Have students put the small piece of food on the paper clip "platform."

10. Have students use the thermometer to take the temperature of the water. Record the starting water temperature on the data sheet.

11. Have students use the match to light the food. (This is difficult and several tries may be needed.)

12. Have students quickly place the large can over the food, and the juice can into the larger can resting the nails in the notches, so that the heat from the burning food goes up into the water.

13. The food may burn or may need to be relit. It is ok to relight it quickly by lifting the large can. Do not heat the small can with the match.

14. When the food has burned for at least one minute, have students remove the water and find the change in temperature. Then they should take the temperature of the water and record it.

15. Have students carefully remove the food from the paper clip and re-mass. [If you use marshmallows, use them last because the sugar sticks to the paper clip.] Record the ending mass of the food on the data sheet.

16. Calculate the mass lost from the food by burning: Beginning mass – final mass = mass lost. Record the change in mass on the data sheet.

17. Calculate the energy gained by the water: Final temperature – beginning temperature. Record the change in temperature on the data sheet. Now, divide by 100 to find the calories used to heat the water (or you might say, released by the burning food). Record the calories on the data sheet. Note: A "small c" calorie is enough heat to raise l gram of water l degree. One ml of water = 1 gram of water.

18. Calculate the calories per gram for the food burned: Calories/grams lost = calories per gram.

19. Ask students what the major sources of error are in the experiment. [Heat loss, of course, is the most significant.]

20. Compare the calories in nuts with the calories in the crouton, in marshmallows, or in other dry foods. [In general, fats contain 9.3 kilocalories (<u>C</u>alories) per gram, whereas both carbohydrates and proteins contain only about 4.1 kilocalories per gram. The nuts contain both fat and protein and should have more calories per gram than the starch in a crouton or the sugar in a marshmallow.]

Counting Calories

Name: ___________________________________
Date: ____________________________________

Brainstorming: Burning a candle is like burning food because:
____

My Observations: Food Combustion Lab

Food	Starting Mass	Ending Mass	Change in Mass	Starting Temp.	Ending Temp.	Change in Temp.	Calories	Calories Per Gram

Questions:

1. Which food has the most calories in each gram?

2. Which food has the least calories in each gram?

3. What are the sources of error in this experiment?

4. How could this experiment be improved?

5. What do cells get from food?

6. What must happen to food before our cells can use it?

7. Given what we now know, what is food?

8. How do we get the energy out of food?

9. Is it easy to burn food?

Teacher Background Information

Counting Calories SC070103

This lab is a simulation that provides reasonable data, but will not give precise calorie information because of the significant heat loss. Students can, however, get good *relative* data; that is, they will find that peanuts release more calories than bread. They can also compare foods with different fat contents to demonstrate that fat increases the calorie content of food.

They may have to relight the peanut several times. The freeze-dried versions burn best. Of course, this requires a class with reasonably good discipline. Matches can be a source of mischief if discipline is not maintained.

Encourage students to suggest alternative foods. Dried fruits have been successfully burned. You can get good relative data by comparing low fat Tostitos and Doritos. As students discuss which foods to choose, emphasize small pieces and low moisture. The idea that oxidation works best when the food is in small pieces can be extended to the idea of physical digestion.

If you use marshmallows, you may want to do them last. Also, students may find that they have to mass the paper clip and the burned marshmallow, and then subtract out the weight of the paper clip because it will be covered with burned sugar.

Suggested Rubric for Assessment "Design a Better Calorimeter"

Level Characteristic

0 Student does not indicate an understanding that a calorimeter is a chamber to hold heat.

1 Student draws a calorimeter essentially the same as the class experiment that holds heat but is not improved.

2 Student increases the thickness of the insulation or the number of layers to improve heat retention.

3 Student increases heat retention and increases airflow.

4 Student improves heat retention, airflow, and combustion of food.