Cooking Food

Unit: Nutrition & Wellness

Problem Area: Nutrition, Wellness, and Lab Skills

Lesson: Cooking Food

Student Learning Objectives.

Instruction in this lesson should result in students achieving the following objectives:

1. **Compare and contrast how heat is transferred in cooking.**
2. **Identify dry and wet cooking methods.**
3. **Practice reading a thermometer.**
4. **Recognize when a food product is done.**

Resources.

The following resources may be useful in teaching this lesson:

E-unit(s) corresponding to this lesson plan. CAERT. Inc. http://www.mycaert.com

"Cookware Materials - Which is Best?," *Kitchen Kapers.* Accessed July 16, 2019. https://www.kitchenkapers.com/pages/cookware-materials-and-why-they-matter.

Mehas, Kay, and Rodgers, Sharon. *Food Science The Biochemistry of Food and Nutrition.*5th ed. McGraw-Hill Education. 2009.

"Glass, metal, or silicone? Pick the right bakeware for the task," *Oregonlive.* Accessed July 17, 2019. https://www.oregonlive.com/foodday/2010/11/glass_metal_silicone_pick_righ.html.

"The Best Techniques for Knowing When Food is Cooked," *Cooking Manager.* Accessed July 18, 2019. http://www.cookingmanager.com/food-cooked/.



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Equipment, Tools, Supplies, and Facilities

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials
- ✓ Supplies below are suggested for the Interest Approach:
- ✓ Microwave oven
- ✓ Two towels
- ✓ Tongs
- ✓ Water
- ✓ Liquid measuring cup
- ✓ Stovetop (electric or gas)
- ✓ Three pots (two of equal size and one large enough to fit one of the smaller ones inside)
- ✓ Timer or watch with a second hand

Key Terms. The following terms are presented in this lesson (shown in bold italics):

Heat Transfer Terms.

- clad
- conduction
- convection
- heat
- heat transfer
- induction
- infrared
- molecules
- radiation

Cooking Method Terms.

- bake
- boil
- braise
- broil
- deep-fry
- dry heat cooking methods
- fry
- grill
- moist heat cooking methods
- pan-fry
- roast
- sauté
- simmer
- steam
- stew
- stir-fry

Thermometer Terms.

- Celsius
- Fahrenheit
- instant read thermometer
- temperature
- thermometer

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Interest Approach.

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Demonstration one:

- *Take two identical saucepans and add exactly two cups of water to each pan.*
- *Place one saucepan inside an empty larger pan.*
- *Put the single pan and the "doubled up" pan on the stovetops over identical heat levels.*

Questions:

- *How long did it take for both pans of water to boil?*
- *Which pan took longer to boil?*
- *Why did one pan take longer?*
- *What is the heat transfer method conduction?*
- *How does conduction affect the boiling of each pan?*

Teacher Notes: You may not want to wait for the "doubled up" pan to boil. Another option is to take the temperature of the "doubled up" pan of water and compare the temperature of the saucepan of boiling water. Conduction is the transfer of heat directly from one source to another—direct physical contact. Heat through conduction is demonstrated as simply as putting a pan on a stove and turning on the flame (or coil). The heat (or energy) from the stove physically touches the pan. In the pan that was "doubled up", the heat did not touch the pan with the water so conduction heat transfer happens slowly.

Demonstration two:

- *Gather two identical hand towels.*
- *Soak one in water and wring it out.*
- *Leave the other towel dry.*
- *Put both towels in a microwave oven and heat them on high for one minute.*
- *Remove the towels from the oven.*

Questions:

- *Why is one towel hot and one is not?*
- *What is the heat transfer method radiation?*

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- *What does radiation have to do with one towel being hot and the other remains cool?*
- *What conclusions can you make about cooking food in a microwave?*

Teacher Notes: (CAUTION: The wet one will be hot—use tongs to remove.) Allow students to see the steam rising from the wet towel. Microwave ovens cook by radiation that heat up water molecules in food. The food absorbs the raw radiant energy and is cooked by the vibration of water molecules in the food. Glass, china dishes, paper towels, etc. do not heat or burn in a microwave oven. If the coverings feel hot after cooking, it is due to heat being transferred from the food to the cookware or covering, not from the microwaves. The waves pass harmlessly through nonporous cookware, but they will bounce off, spark, and react violently when they come in contact with tin, aluminum, or similar metals.

CONTENT SUMMARY AND TEACHING STRATEGIES

Objective 1: Compare and contrast how heat is transferred in cooking.

Anticipated Problem: How is heat transferred in cooking?

I. ***Heat*** is a combination of kinetic (movement) energy and temperature (a measurement of heat). ***Heat transfer*** is a form of energy that moves heat to food.

A. In general, heat is transferred from one material to another in one of three ways: conduction, convection, or radiation.

1. ***Conduction*** is the transfer of heat directly from one source to another—direct physical contact of colliding ***molecules*** (the smallest unit of a molecular compound).
   a. Heat through conduction is demonstrated as simply as putting a pan on a stove and turning on the flame (or coil). The heat (or energy) from the electric or gas range physically touches the pan.
   b. The heat moves from the bottom of the pan, through the pan, and into the food in the pan. Conduction is heat traveling through food.
2. ***Convection*** is heat transfer involving natural and mechanical movements of a liquid or gas. Natural convection involves warm air (or liquid) rising and cool air (or liquid) falling. Mechanical convection involves fans or stirring to cause movements.
   a. Convection ovens have fans that move the heat and speed up the cooking time. These ovens cook 25 percent faster at a temperature 25 percent lower than a conventional oven.

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b. If a sauce is stirred while heating, the heat will transfer more rapidly throughout the food.

3. The heat transfer method, ***radiation*** is extremely different from conduction and convection. Radiation is a type of heat transfer that occurs by moving ***infrared*** rays or electromagnetic waves.
   a. Radiation uses heat or light to pass through molecules. Infrared waves are used in toasters and broilers. Microwaves use electromagnetic waves. No heat transfer medium is necessary.
   b. The food absorbs the raw radiant energy and is cooked by the vibration of water molecules in the food.

B. ***Induction*** ranges use the process of releasing magnetic currents (generated by a high-frequency induction coil) that react only with certain ferrous (containing iron) metals that allow the heat energy to pass into the metal and then into the food.
   a. No flame or red coil is visible, and the "burner" surface emanates no heat of any kind. This is a safe cooking surface for young children and older adults because the cooking surface is always cool.
   b. Cooking on an induction range requires special pans.

C. Heat transfer mediums are the actual "material" the heat is moving through: a pan, air, water, steam, or oil. The medium has a direct effect on how rapidly a food cooks.

1. Pans can be made of many types of material. All pans do not transfer heat the same. The gauge or thickness of the metal also affects the transfer of heat.
   a. Copper, aluminum, carbon steel, and cast iron are excellent conductors of heat (listed in order of best heat transfer). However, copper cannot be used alone in most cookware because it reacts with minerals and acid in foods causing a yellow color and bitter taste. Cast iron takes a long time to heat and cool. Cast iron retains the heat well and is the preferred material for Dutch ovens, fry pans, griddles, and grill pans.
   b. Stainless steel does not heat food as evenly as these other metals and is often ***clad*** with copper or another metal (covered with a layer of copper on the bottom of the pan).
   c. Clay and stoneware are the oldest cookware. They heat very evenly and hold heat well without hot spots. Clay and stoneware are used in the oven.
2. Each heating media (air, water, steam, and fat) transfers heat at different rates.
   a. Steam is hotter than any temperature of water.
   b. Fat can be heated to a much higher temperature than water.
   c. When you roast, bake, broil, or grill you are primarily cooking with air as the heat medium.
   d. Food cooks quicker in a hotter heating media (e.g., chicken takes longer to cook in the oven than chicken that is fried).

Teacher Note: A turkey cooking oven plastic bag cooks a turkey by both air and steam.

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D. Heat conduction in bakeware — should you choose glass, dark metal, shiny metal, or silicone?

1. Glass is not a good conductor of heat compared to metal. Glass retains heat well, so the food cooks faster. Baked goods baked in glass may become overbrown before getting done. The oven temperature is often reduced 25 degrees when baking in a glass pan.
2. Dark metal absorbs more heat than shiny metal. This means foods cook faster and brown more. If you do not want a very brown cookie bottom, cover the dark metal pan with foil, parchment paper, or lower the oven temperature 25 degrees.
3. Shiny metal pans (e.g., aluminum) are an excellent heat conductor. Foods bake quickly and become golden brown.
4. Silicone is lightweight, flexible, and nonstick. Silicone is not a good heat conductor, so foods baked in silicone pans do not brown well. If you want a delicate cookie or cakes, silicone is the best choice. Because silicone is so flexible, the silicone bakeware is often placed on a tray before placing in the oven.

Teaching Strategy: *Many techniques can be used to help students master this objective.*

- *Use VM–A to introduce the lesson.*
- *VM–B is a visual of the three heat transfer methods. Have students define the terms by looking at the graphic.*
- *VM–C has a variety of pictures of pans made from different materials. Help students to identify the different types of metal in pans.*
- *LS–A has students experiment with different types of metal pans to compare and contrast the different metal pans for color, hot spots, and even browning.*
- *Have students research "How Cooking Works: Convection and Conduction", at https://www.thespruceeats.com/how-cooking-works-getting-food-hot-995430. The website also has a video, "What does roasting mean?"*
- *For information on the history of microwaves, see https://home.howstuffworks.com/microwave.htm.*

Objective 2: Identify dry and wet cooking methods.

Anticipated Problem: What are the dry and wet cooking methods?

II. Cooking methods can be categorized as dry or moist. Heat makes food palatable and easier to digest.

A. When food is heated:

1. Fats melt
2. Water evaporates

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3. Starches gelatinize (swell or thicken)
4. Proteins coagulate (harden).
5. Sugars caramelize (brown).

B. Food is cooked by dry and moist cooking methods.
   1. ***Dry heat cooking methods*** (e.g., cooking with air)
      a. Baking—To ***bake*** is to cook food in an oven with hot, dry heat all around the food.
      b. Broiling—To ***broil*** the food is placed under a hot coil unit in an oven—as opposed to roasting and baking, which cook by means of heated air.
      c. Grilling—To ***grill*** is to cook on a hot grid, grate, or solid surface.
      d. Roasting—To ***roast*** is to cook food under dry heat—often in an oven.
   2. ***Moist heat cooking methods*** (e.g., cooking in water, moisture, or steam)
      a. Boiling—To ***boil*** is to cook food in 212°F liquid that is bubbling vigorously and steaming.
      b. Braising—To ***braise*** is to use a combination cooking method of baking and steaming tough cuts of meat.
      c. Simmering—To ***simmer*** is to cooking foods in liquid or sauces just below the boiling point (195°F) so the surface barely ripples.
      d. Stewing—To ***stew*** food is cooked in liquid or sauce with vegetables.
   3. Steaming is a variation of moist heat. To ***steam*** is to cook food on a perforated rack or pan over boiling water in a covered pan.
   4. Frying food in fat is also a variation of moist heat. To ***fry*** is to cook food in hot oil or fat until a crisp brown crust forms. Examples of frying:
      a. Deep fat frying—To ***deep-fry*** is to cook food by completely submerging it in hot fat or oil.
      b. Pan frying—To ***pan-fry*** is to cook food in a hot pan with a small amount of hot oil, butter, or some other fat.
      c. Sautéing—To ***sauté*** is to cook food quickly over very high heat in a small amount of fat.
      d. Stir-frying—To ***stir-fry*** is to sauté small pieces of meat and vegetables quickly over very high heat while stirring continuously and rapidly.

C. Relationship of heat transfer methods to dry and moist heat cooking
   1. Many cooking tasks (e.g., braising) require more than one form of heat transfer.
   2. Steaming, boiling, deep frying, and sautéing cause effective heat transfer by conduction.
   3. Steaming, baking, and roasting cause effective heat transfer by convection.
   4. Broiling, grilling, and microwaving all use heat transfer by radiation.
   5. Even when removed from the heat, food continues to cook using heat transfer methods for a few minutes. This is called “carryover cooking” or “rest time”.

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Teaching Strategy: *Many techniques can be used to help students master this objective.*

- *Utilize VM–D to categorize cooking terms into categories of dry heat cooking or moist heat cooking methods.*
- *Consider a food lab activity: Stir-fry or steamed vegetables with dipping sauce.*

Objective 3: Practice reading a thermometer.

Anticipated Problem: How do you read a thermometer?

III. A ***thermometer*** is an instrument for determining temperature of the surface or the internal temperature of foods.

A. Types of thermometers

1. A common thermometer consisting typically of a glass bulb attached to a fine tube of glass with a numbered scale and containing a liquid (mercury or colored alcohol) that is sealed in and rises and falls with changes of temperature (e.g., candy thermometer).
2. An ***instant read thermometer*** provides quick and accurate internal temperature readings. The most common type used is a bimetallic stem thermometer. When a thermometer is used to test the doneness of meat, it is placed in the thickest part without touching bone. Instant read thermometers are often digital read, unlike glass tube thermometers.

B. The ***temperature*** (hotness or coldness of something) is calculated by degrees (°) on a scale. Thermometers temperature range should be considered. Thermometers for deep fat frying and candy making can calculate higher temperatures than room thermometers.

The temperature scales are Fahrenheit and Celsius.

1. ***Fahrenheit*** is a thermometric system in which waters freezing point is 32 degrees and its boiling point is 212 degrees. Fahrenheit is the customary measurement system used by the United States and a few other small countries. Recipes in the U.S. use Fahrenheit temperature scale.
2. ***Celsius*** is a thermometric system in which 0 degrees is the freezing point and 100 degrees is the boiling point of water. Celsius is used to measure temperature in the metric measurement system. Celsius is used in science experiments and recipes from most parts of the world.
3. Some thermometers show both scales.

C. Reading a glass bulb and tube thermometer

1. Most thermometer scales are divided in two-degree increments.
2. When you read the temperature on a thermometer, it should be vertical and your eyes should be level with the top of the liquid in the glass tube.

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3. Avoid holding the thermometer when reading. The heat from your hands will transfer to the glass causing the temperature to rise or fall. Use a clip to attach the thermometer to the pan. Adjust the thermometer to prevent the bulb from touching the bottom of the pan.

Teaching Strategy: *Many techniques can be used to help students master this objective.*

- *Use VM–E to practice reading a thermometer.*
- *LS–B has students designing line graphs and using a thermometer to measure the temperature of water to boiling. The boiling water continues to boil for five minutes showing a plateau on the chart.*
- *Expand the lesson with VM–F, "Safe Minimum Cooking Temperatures Chart".*
- *VM–G shows a thermometer with pictures of animals to indicate safe temperatures.*
- *VM–H indicates the six ways to order a steak. Blue or blue rare is a new one.*

Objective 4: Recognize when a food product is done.

Anticipated Problem: How do you know when a food product is done?

IV. Knowing when a food product is done is a correlation between time, temperature, touch, smell, visual, sound, and other unique techniques. Some examples include:

A. Time and Temperature

1. Time: When setting a timer to indicate the finish time of baking, use the shortest amount of time if the recipe indicates a range (e.g., 10–12 minutes). If only one time is listed, shorten the time and check for doneness early. You can always set the timer again.
2. Temperature: For food safety, follow the safe minimum cooking temperature charts. For information, see the "Safe Minimum Cooking Temperatures Charts" at https://www.foodsafety.gov/food-safety-charts/safe-minimum-cooking-temperature.

B. Using your senses

1. Touch: Touch is used for many food items to determine if they are done.
   a. Custard based pies or cheese cake — outside should be firm when touched but the inside slightly wobbly.
   b. Cakes and sweet dessert breads (e.g., banana nut bread) — softly touch the center and it feels springy and leaves no indentation.
2. Smell: Most food will have a pleasant roasting or caramelizing aroma when done.

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3. Visual: This is the most used sense when determining if a food is done.
   a. Cakes should pull away from the sides. Cakes should not wiggle when moved. Insert a toothpick or cake tester in the center of the cake and it should come out clean.
   b. Lift a loaf of yeast bread and check for browning on the bottom.
   c. When bubbles appear on top of the pancakes, it is time to flip them.
   d. When liquids run clear in poultry, fish, well-done meat, and hamburgers.
   e. Vegetables are pierces through the center with a fork or sharp knife.
   f. Rice should have all the liquid absorbed.
   g. Casseroles and quiches should be brown on the top.
4. Sound: Listen for a hollow sound when you tap yeast bread to indicate doneness.
5. Mouthfeel: Mouthfeel is the sensation of the food in the mouth. Pasta should be "Al dente" or it should be cooked just long enough to still be firm, and not too soft.

Teaching Strategy: *Many techniques can be used to help students master this objective.*

- *Give the students ten minutes to pick a partner and research two recipes that indicate when a food is done (not cookies). Have them report their findings to the class.*
- *While the students are researching, use slice and bake cookie dough and bake the cookies. Show several ways to determine if the cookie is done. Discuss why some prefer to remove cookies from the oven and let them sit to finish baking (carryover heat). Discuss smell, sight, touch, mouthfeel, and the wonderful aroma of baked cookies and how this indicated they were done. If it is a crisp cookie, you can discuss sound.*

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. If a textbook is being used, questions at the ends of chapters may also be included in the Review/Summary.

Application. Use the included visual master(s) and lab sheet(s) to apply the information presented in the lesson.

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

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Answers to Sample Test:

Part One: Completion

1. Fahrenheit, Celsius
2. conduction, convection, and radiation
3. melt, evaporate
4. air, water, steam, oil
5. hotter or fat
6. 25
7. carryover or rest time
8. instant read
9. heat transfer
10. cool

Part Two: True/False

1. F
2. F
3. T
4. T
5. F
6. T
7. T
8. T

Part Three: Short Answer

1. Answers will vary. See “Content Summary”: I.C.1.a.-c.
2. Answers will vary. See “Content Summary”: IV.B.1.-5.
3. Answers will vary. See “Content Summary”: II.B.1.a.-d,2.a-d.,3.4.a-d.

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Sample Test

Name _____

Cooking Food

Part One: Completion

Instructions: **Provide the word or words to complete the following statements.**

1. The two temperature scales are _____ and _____.
2. In general, heat is transferred from one material to another in one of three ways: _____, _____, or _____.
3. The effects of heat on food are to make food palatable and easier to digest. Two effects include making fats _____ and water _____.
4. Heat transfer media include cooking equipment (pans, pots, etc.) and _____, _____, _____, and _____
5. Food cooks quicker in _____heating media
6. The oven temperature is often reduced _____degrees when baking in a glass pan.
7. Even when removed from the heat, food continues to cook using heat transfer methods for a few minutes. This is called _____.
8. The thermometer that provides quick and accurate internal temperature readings is called _____.
9. A form of energy that moves heat to food is called _____.
10. Induction ranges are safe cooking surface for young children and older adults because the cooking surface is always _____.



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Part Two: True/False

Instructions: **Write *T* for true or *F* for false.**

_____1. Microwave ovens use infrared rays to heat food.

_____2. Boiling water is an example of conduction energy.

_____3. All pans do not transfer heat the same.

_____4. Thermometers for deep fat frying and candy making can calculate higher temperatures than room thermometers.

_____5. Adjust the glass bulb thermometer to touch the bottom of the pan.

_____6. When setting a timer to indicate the finish time of baking, use the shortest amount of time if the recipe indicates a range.

_____7. The gauge or thickness of the metal also affects the transfer of heat.

_____8. Silicone is not a good heat conductor, so foods baked in silicone pans do not brown well.

Part Three: Short Answer

Instructions: **Answer the following.**

1. Compare and contrast the heat transfer and other aspects of three metals used in pan construction.

2. Explain how each of our senses identifies if a food is done. Give one example of each.

3. Name five cooking method terms. Give a full definition of each.

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INTRODUCTION TO "COOKING FOOD" LESSON

Demonstration one:



- Take two identical saucepans and add exactly two cups of water to each pan.
- Place one saucepan inside an empty larger pan.
- Put the single pan and the "doubled up" pan on the stovetops over identical heat levels.

Questions:

- How long did it take for both pans of water to boil?
- Which pan took longer to boil?
- Why did one pan take longer?
- What is the heat transfer method conduction?
- How does conduction affect the boiling of each pan?

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Demonstration two:



- Gather two identical hand towels.
- Soak one in water and wring it out.
- Leave the other towel dry.
- Put both towels in a microwave oven and heat them on high for one minute.
- Remove the towels from the oven.

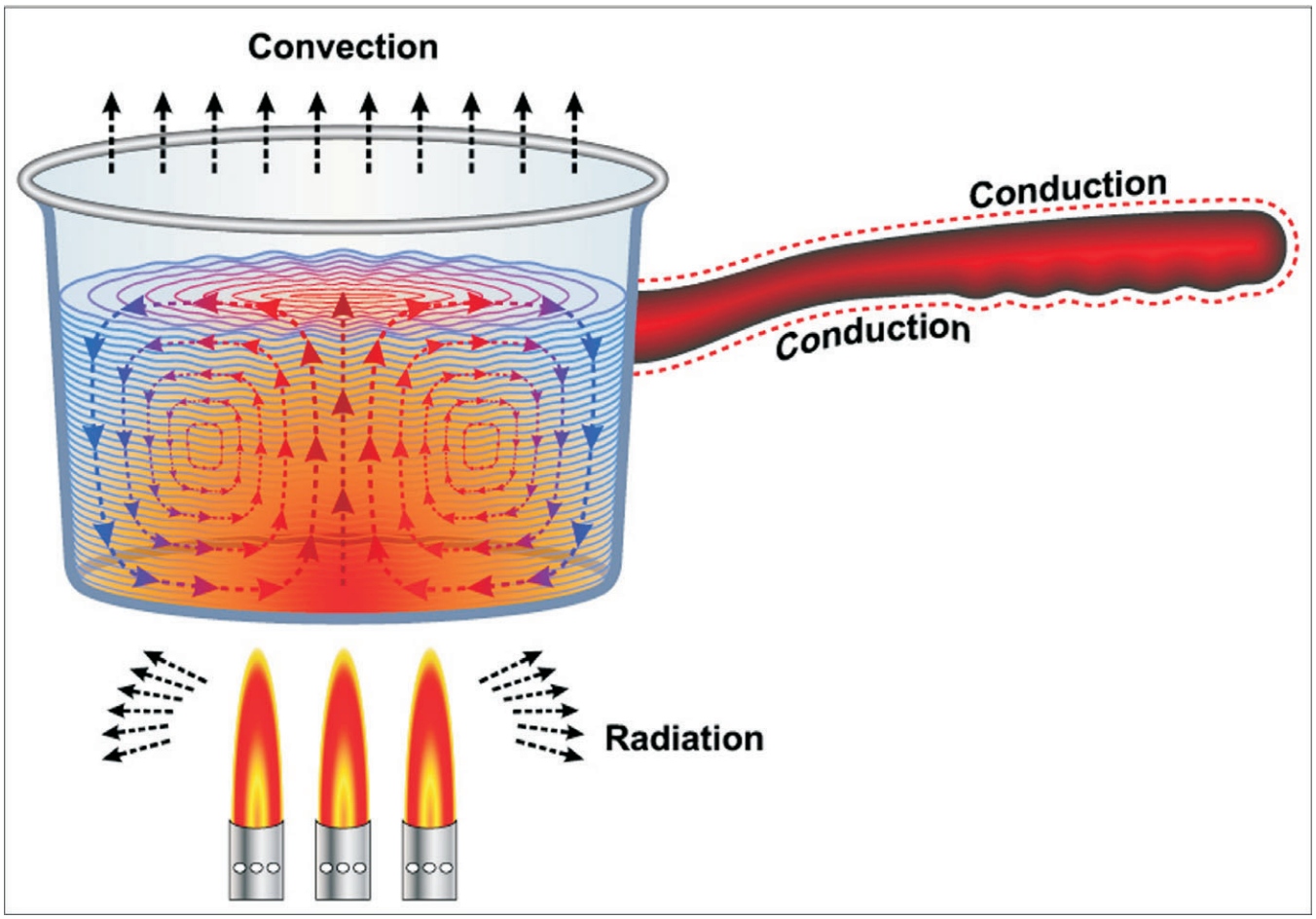
Questions:

- Why is one towel hot and one is not?
- What is the heat transfer method radiation?
- What does radiation have to do with one towel being hot and the other remains cool?
- What conclusions can you make about cooking food in a microwave?

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HEAT TRANSFER

Use the picture to explain the difference between conduction, convection, and radiation.



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METALS THAT ARE USED IN POTS AND PANS

Can you identify the metals used in each pot or pan?













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DRY AND MOIST HEAT COOKING METHODS

Match the cooking terms to the dry heat or moist heat cooking method. Define each term.

- bake
- boil
- braise
- broil
- deep-fry
- fry
- grill
- pan-fry
- roast
- sauté
- simmer
- steam
- stew
- stir-fry



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READING A THERMOMETER

The left side of the thermometer is °C. The right side of the thermometer is °F. What is the temperature on this outside thermometer in both scales?



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SAFE MINIMUM COOKING TEMPERATURES CHART

Food	Type	Internal Temperature (°F)
Ground meat and meat mixtures	Beef, pork, veal, lamb Turkey, chicken	160 165
Fresh beef, veal, lamb	Steaks, roasts, chops Rest time: 3 minutes	145
Poultry	All poultry (breasts, whole bird, legs, thighs, wings, ground poultry, giblets, and stuffing)	165
Pork and ham	Fresh port, including fresh ham Rest time: 3 minutes Precooked ham (to reheat) Note: Reheat cooked hams packaged in USDA-inspected plants to 140°F	145 165
Eggs and egg dishes	Eggs Egg dishes (such as frittata, quiche)	Cook until yolk and white are firm 160
Leftovers and casseroles	Leftovers and casseroles	165
Seafood	Fish with fins Shrimp, lobster, crab, and scallops Clams, oysters, mussels	145 or cook until flesh is opaque and separates easily with fork Cook until flesh is pearly or white, and opaque Cook until shells open during cooking

(Adapted from Foodsafety.gov at https://www.foodsafety.gov/food-safety-charts/safe-minimum-cooking-temperature)



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MEAT THERMOMETER

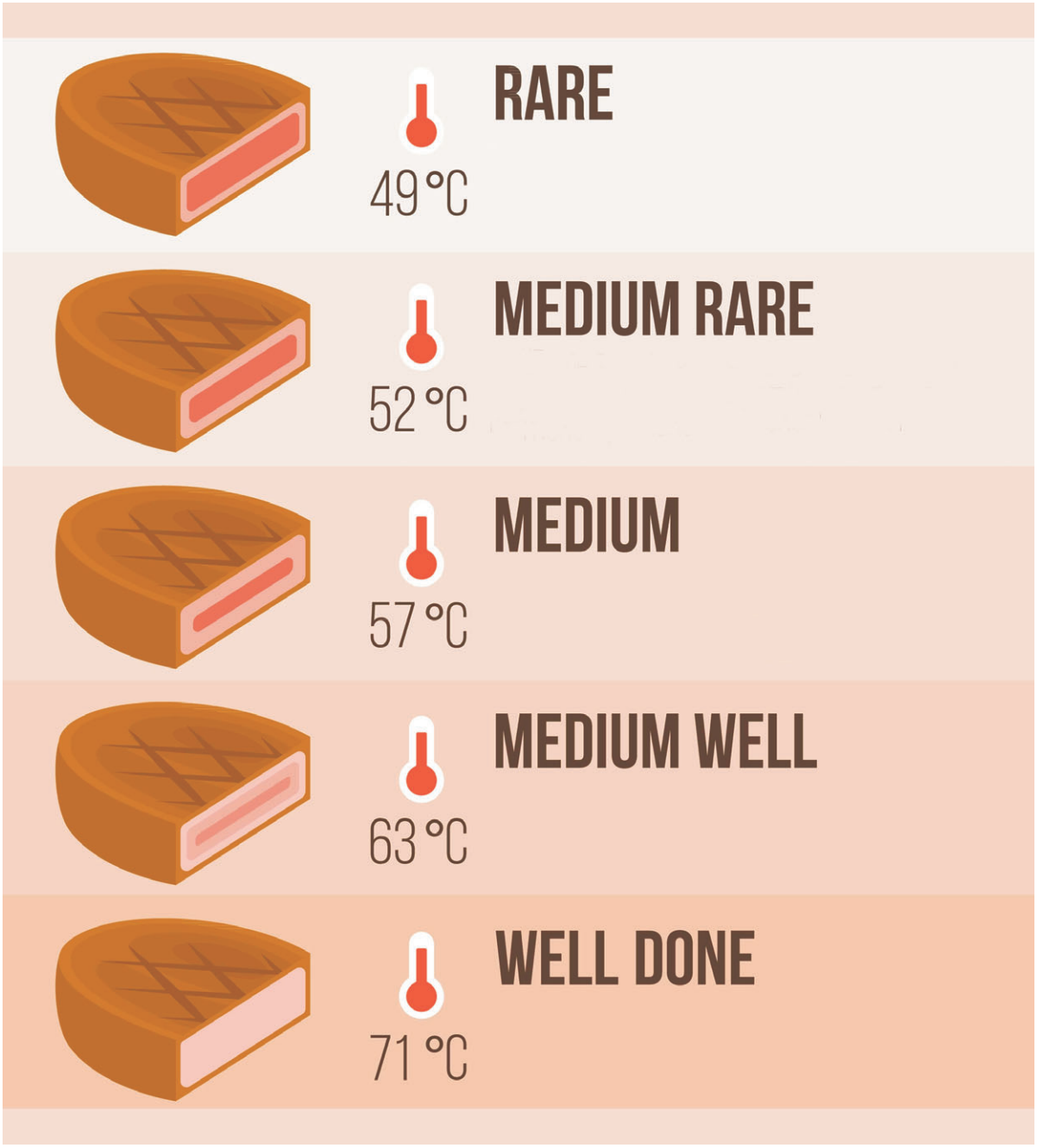
Most meat thermometers show the safe temperatures for different types of meat and poultry. Notice this thermometer is in Fahrenheit and Celsius scales.



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STEAK TEMPERATURE CHART

How do you like your steak cooked? Use an instant read thermometer and get it perfect every time.



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Name _____

Heat Transfer in Different Metal Pans

Purpose

The purpose of this activity is to identify the differences in heated metal pans coated with shortening and flour.

Objectives

1. Identify different metal pans.
2. Compare and contrast the different metal pans for color, hot spots, and even browning.

Materials

- Lab sheet
- 1 pan per lab group: options include light gauge aluminum pan, heavy gauge aluminum pan, light gauge stainless steel pan, heavy gauge stainless steel pan, Teflon coated pan, copper clad pan, or cast iron pan
- Masking tape
- Permanent marker
- Shortening
- Paper towel or pastry brush
- Flour
- Waxed paper
- Range to heat pans
- Writing utensil
- Clock or timer with minute hand



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Procedure

1. The instructor will divide the class into lab groups for this experiment. Each lab group will have 1 pan for the experiment. Each pan should be different in type of metal or gauge. On a piece of masking tape, write the type of metal (and gauge). Place the masking tape on the handle of the pan.
2. Grease the inside of the pan bottom with a light coat of shortening.
3. Dust the top of the shortening with flour. Tap the sides of the pan to evenly coat all the shortening. When the shortening is covered with flour, turn the pan over a piece of waxed paper. Tap on the bottom of the pan to remove any excess flour.
4. If possible, use all electric or all gas ranges. Select the coil or burner to fit your pan. The heat will be placed on the medium setting. Every minute each lab group will write on their data table the looks of the shortening/flour coating. The lab group removes the pan from the heat when all the shortening/flour coating is golden brown. Let the pan cool and allow all the lab groups to observe the final results for data table two. Some pans will have hot burned spots. Some pans will become golden brown quickly. Others will take much longer. Wait for the instructor to tell the lab groups to start the experiment.
5. Complete data table one for your group's type of pan.
6. Complete data table two showing the total time, color, and hot spots (if any) on all the pan types.
7. Write a conclusion on which pan metal has the most even heat transfer without hot spots.
8. Clean-up only after the instructor has indicated everyone has completed data table two.

Data Table One

Heat Transfer of Metal Pan _____

Time	Description of Shortening/Flour Coating	Hot Spots — Yes or No, Shape, Number of Hot Spots
1 minute		
2 minutes		
3 minutes		
4 minutes		
5 minutes		
6 minutes		
7 minutes		
8 minutes		

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Time	Description of Shortening/Flour Coating	Hot Spots — Yes or No, Shape, Number of Hot Spots
9 minutes		
10 minutes		
11 minutes		
12 minutes		
13 minutes		
14 minutes		

Data Table Two

Heat Transfer of Class Experiment on Metal Pan

Type of Pan	Minutes to Golden Brown	Description of Shortening/Flour Coating	Hot Spots

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Name _____

Create a Line Graph: Simple Experiment — The Temperature of Boiling Water

Purpose

The purpose of this activity is to practice designing a line graph to compare two variables for a simple experiment.

Objectives

1. Create a data table for a simple experiment.
2. Draw a line graph to compare experiment results.
3. Record observations on the data table.
4. Compare line graphs for different amounts of water.
5. Write a scientific conclusion.

Materials

- lab sheet
- graph paper
- writing utensil
- gas or electric range
- small sauce pan
- liquid measuring cup
- cold tap water
- thermometer
- pot holder
- clock or time to measure 1 minute at a time



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Procedure

1. The teacher will divide your class into four groups.
2. As a group, design a line graph.
   - The x-axis should show the temperature in 5-degree increments. Take the temperature of the cold tap water and start with this temperature.
   - The y-axis should indicate time and begin at 0, with increments every one minute.
   - Continue increments until five minutes after the water boils.
3. Two groups will begin the experiment with the same volume of water, and two other groups will begin with a different volume of water. For example:
   - Groups A and B use 1 cup of cold tap water.
   - Group C uses 1½ cups of cold tap water.
   - Group D uses 2 cups of cold tap water.
4. Heat the water on high range setting. Select the coil or burner to match the size of the pan. Use the thermometer to take the temperature of the water, and record the temperature on the line graph.
5. Record the temperature every minute on the data table.
6. Continue recording the temperature of the water for 5 minutes after the water boils.
7. Draw the line graph for your water volume.
8. Compare the line graphs of groups with similar volumes and different volumes.
9. Write a scientific conclusion of the experiment.

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Line Graphs and Data Tables

This experiment is simple but it has students designing line graphs and working with scientific data tables and conclusions. It is worth the time.

1. This experiment may take up to 45 minutes for the larger volumes of water to boil for five minutes and then to evaluate all the graphs.
2. All graphs should show water boiling at 212°F (100°C), regardless of the volume of water. The temperature of the water may vary due to the calibration of the thermometers. Show students how to indicate temperatures between the increments.
3. All graphs should show a plateau at which point the temperature remains at the boiling point no matter how long the water boils.
4. Purchase graph paper or print off from website.
5. SAMPLE scientific conclusion: All volumes of water boil at approximately the same temperature and maintain a plateau for five minutes. Time is the variable: Smaller amounts of water boil faster than large amounts.
6. This lab could lead to discussions how sugar added to water (e.g., candy making) allows the water to rise in temperature.
7. For more information on developing line graphs, see https://www.eduplace.com/math/mathsteps/4/c/index.html or research line graphs.

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