

Microwave Mysteries

Beep, Zap, Defrost!



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Suite 301
641 West Lake Street
Chicago, IL 60661
800.634.4941

info@learningseed.com
www.learningseed.com

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The Video

Executive Producer: Kari Dean McCarthy
Writer: Kathleen O. Ryan
Producer: Kathleen O. Ryan/Tracy Ullman
Video Editor: Joanna Beer
Assistant Producer: Jennifer A. Smith
Narrator: Kate Burns

This Teaching Guide

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Copy Editor: Jennifer A. Smith

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Please contact us at:

Learning Seed
Suite 301, 641 W. Lake Street
Chicago, IL 60661
800.634.4941
info@learningseed.com

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This program is closed-captioned.

Summary

This program reveals the secrets of how microwave ovens work, whether they use heat and the science behind how they cook food. Learn what it means to cook according to microwave power levels versus the traditional temperature-centered operation of a conventional oven. See procedures for proper food preparation specific to microwave cooking requirements, appropriate utensil and container usage and oven safety features. Microwave cooking tips and meal preparation techniques are presented.

How Microwave Ovens Work

Learn:

- How electricity travels from the wall socket through energy conversion onto the point where the molecules excite and cook food using microwave energy
- The effect of microwaves on glass, ceramics and plastic containers and on foods with varying degrees of water, fat and sugar
- The concern with possible hot spots
- How foil covered trays or sleeves are used to brown and crisp food
- The importance of resting or standing time after the microwave turns off

Understanding Microwave Power

In a conventional oven, food is cooked based upon the temperature of the oven, but microwaves do not use specific temperatures because they do not give off heat. The whole heating process is different because the process involves exciting atoms, creating atomic activity and radiation, rather than conducting heat.

Microwave Safety

Microwave ovens have safety features that keep microwaves inside. Safe food handling and operational safety concerns covered include the superheating of liquids, and the arcing caused by the use of metal in the oven.

Cooking Techniques and Tips

Learn:

- Techniques including food placement and arrangement
- How covering food retains moisture and prevents splattering
- Why stirring, rotating and turning foods ensures even heating
- Handy microwave tips

Safety Tips

Microwave Safety

So, can we put this in the microwave?

Steer Clear:

- Brown paper bags
- Newspaper
- Decorated paper towels and napkins
- Carryout containers
- Previously used frozen dinner trays
- Foil
- Styrofoam
- One-time containers
- Baby food jars and baby bottles
- Glass food containers
- Metal trimmed containers

It's a Go:

Specially manufactured for microwave ovens:

- Dishware
- Containers
- Glass cookware
- Ceramics

as well as:

- Plastic wraps
- Waxed paper
- Cooking bags
- Parchment paper
- White microwave-safe paper towels
- Paper plates labeled "microwave safe"

TIP: If the microwave door does not close properly, or the oven is damaged in any way, do not use it.

Food Safety

Making sure it's just right ...

- Arrange food items evenly, then cover the dish with a lid or plastic wrap; a circle around the outer edge of the dish is the best configuration. Loosen or vent the lid or wrap to let steam escape.
- Large cuts of meat (thicker than an inch) should be cooked on medium (50% power) for longer periods, never on High (100% power), so that heat can reach the center without overcooking the outside.
- Stir, turn or rotate food mid-way through the microwaving time to ensure even cooking.
- Foods defrosted or partially cooked in the microwave should be moved immediately to the oven or grill to complete the cooking process because some areas of the frozen food may begin to cook during the initial heating process.
- Heat precooked foods and leftovers thoroughly – until they are steaming.
- Insert a food thermometer into the thickest part of poultry or meat (away from the bone) to ensure proper cooking temperatures have been reached.
- Always allow standing time to complete the cooking process before using a food thermometer.
- Red meat should be 160 °F, whole poultry 180 °F, and egg casseroles 160 °F.
- Fish should flake with a fork.
- Avoid cross-contamination when preparing and cooking food by not using the same utensils, cutting surfaces and dishware for fresh fruits and vegetables that are used for uncooked meats.

Discussion Points and Activities

On the Board

- 1) Ask the class which products or containers are **safe** and **which are not safe** to use in the microwave oven, and list them on the board.

<u>SAFE</u>	<u>UNSAFE</u>
Glass, plastic, & ceramics labeled <i>microwave safe</i>	Whipped topping and margarine tubs
Microwave plastic wraps	Carryout containers
Wax paper	Any one-time use container
Cooking bags	Previously used frozen dinner trays
Parchment paper	Plastic storage bags
White microwave-safe paper towels	Brown paper or plastic grocery bag
	Newspapers
	Aluminum foil
	Styrofoam
	Metal trimmed containers

- 2) Follow up with – **Why are some of these containers unsafe?**
- Plastic that is not microwave safe can warp or melt, possibly causing harmful chemicals to migrate into the food.
 - Metals and papers can cause a fire in the oven.

In the Oven

Teacher's demonstration: **Why water should never be heated alone in the microwave oven.**

Background: Heating water alone in a microwave can be dangerous. *Superheating* can result in the water *erupting*, or violently boiling over, particularly if the bowl or cup is new and without small nicks or flaws in which bubbles can form. Water heated in the microwave can appear to be still, as if it has not reached the boiling point, when in reality, the water is quite volatile. A mere bump to the cup can set the water in motion.

Demonstration: Place two identical cups $\frac{3}{4}$ filled with water, one with a wooden coffee stirrer in it, into a microwave oven. Set the oven on High for two minutes. When timer goes off, remove both cups while wearing an oven mitt. Place the cups in the middle of the table at a safe distance from everyone, taking care not to bump them in the process.

Still wearing the mitt, place a teaspoon in the cup without the wooden stick and begin to stir – bubbles should form rapidly. The water has been heated faster than vapor bubbles could form, and without the bubbles, the heat was not released, so the water continued to heat past the boiling point.

Now use the spoon to stir the water in the other cup. The water should remain still; the stick helped diffuse the energy while the water was heated.

To avoid burns from superheated water:

- Always place a wooden coffee stirrer in the liquid when heating.
- Let all heated liquids cool for a few minutes before removing them from the microwave.

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Matching Quiz

Match the words in the first column to the best available answer in the second column.

_____	Raising a molecule to a higher energy level.	1) radiation
_____	The continual movement of molecules that occurs when heat accelerates atoms.	2) magnetron tubes
_____	Creates the radio wave signals used in radar and microwave ovens.	3) molecules
_____	The smallest particle; made up of one or more atoms.	4) radar
_____	Uses a transmitter to emit radio waves called microwaves.	5) magnetron
_____	Converts high voltage electricity into very short waves of energy.	6) atomic motion
_____	Energy that travels outward in straight lines.	7) exciting
_____	Current or field used to convey data from one place to another.	8) conduction
_____	Very short waves of electromagnetic energy.	9) microwave energy
_____	Flow of thermal energy through a substance.	10) radio wave signal

Microwave Mysteries

Matching Quiz Answer Key

<u>7</u>	Raising a molecule to a higher energy level.	1) radiation
<u>6</u>	The continual movement of molecules that occurs when heat accelerates atoms.	2) magnetron tubes
<u>5</u>	Creates the radio wave signals used in radar and microwave ovens.	3) molecules
<u>3</u>	The smallest particle; made up of one or more atoms.	4) radar
<u>4</u>	Uses a transmitter to emit radio waves called microwaves.	5) magnetron
<u>2</u>	Converts high voltage electricity into very short waves of energy.	6) atomic motion
<u>1</u>	Energy that travels outward in straight lines.	7) exciting
<u>10</u>	Current or field used to convey data from one place to another.	8) conduction
<u>9</u>	Very short waves of electromagnetic energy.	9) microwave energy
<u>8</u>	Flow of thermal energy through a substance.	10) radio wave signal

Microwave Mysteries

Fill-In-The-Blank

Select the correct term from the list below and write it in the blank space. Some terms may be used more than once, while others not at all.

1. A _____ is a measurement of electrical power; a unit of electrical measurement equal to the current of one ampere produced by the electromotive force of one volt.
2. The whole heating process of a microwave oven is different because you are _____ atoms rather than conducting heat.
3. A bacterium present in the lower intestine of humans and warm-blooded animals, _____ can cause a life-threatening gastrointestinal infection when it makes its way into food supplies.
4. The continual movement of molecules that occurs when heat accelerates atoms, causing them to break atomic bonds is called _____.
5. To remove any doubt about how to cook popular dishes, some microwaves come equipped with _____ that are pre-set so the oven cooks foods just right.
6. When the microwave is plugged in, electricity travels through the power cord and enters the machine through its _____.
7. A microwave oven converts the electricity from the wall socket into a high voltage that passes through a _____ that converts it into electromagnetic energy.
8. When a recipe calls for cooking the food for 2 minutes at 50%, or medium power, the oven releases full power waves to cook the food, but for only _____ the amount of time that the food is inside.
9. Often, ovens have a “defrost” button, which is usually programmed according to the weight of the frozen food. The oven begins by using long bursts of continuous waves that _____ as the food thaws.
10. _____ refers to the sparks created when microwaves react to metallic substances inside the oven. Sparks can damage the oven or start a fire.

smart buttons	magnetron tube	E. coli	full	decrease	atomic motion	amp
watt	increase	microwave energy	arcing	safety circuits	half	exciting

Microwave Mysteries

Fill-in-the-Blank Exercise Answer Key

1. A **watt** is a measurement of electrical power; a unit of electrical measurement equal to the current of one ampere produced by the electromotive force of one volt.
2. The whole heating process of a microwave oven is different because you are **exciting** atoms rather than conducting heat.
3. A bacterium present in the lower intestine of humans and warm-blooded animals, **E. coli** can cause a life-threatening gastrointestinal infection when it makes its way into food supplies.
4. The continual movement of molecules that occurs when heat accelerates atoms, causing them to break atomic bonds is called **atomic motion**.
5. To remove any doubt about how to cook popular dishes, some microwaves come equipped with **smart buttons** that are pre-set so the oven cooks foods just right.
6. When the microwave is plugged in, electricity travels through the power cord and enters the machine through its **safety circuits**.
7. A microwave oven converts the electricity from the wall socket into a high voltage that passes through a **magnetron tube** that converts it into electromagnetic energy.
8. When a recipe calls for cooking the food for 2 minutes at 50%, or medium power, the oven releases full power waves to cook the food, but for only **half** the amount of time that the food is inside.
9. Often, ovens have a “defrost” button, which is usually programmed according to the weight of the frozen food. The oven begins by using long bursts of continuous waves that **decrease** as the food thaws.
10. **Arcing** refers to the sparks created when microwaves react to metallic substances inside the oven. Sparks can damage the oven or start a fire.

Microwave Mysteries

Multiple Choice

Circle the best answer for each question.

<p>1. Microwave ovens do not use specific temperatures because they don't:</p> <ul style="list-style-type: none">a) give off heatb) use a transmitterc) stir or rotated) superheat foods	<p>6. In microwave ovens, the energy used to cook foods is measured in:</p> <ul style="list-style-type: none">a) full power wavesb) watts of electricityc) both Fahrenheit and Celsiusd) voltage
<p>2. Three important things to know about power in microwaves does <u>not</u> include:</p> <ul style="list-style-type: none">a) Microwaves are always released into an oven at full power.b) Microwaves are released into the oven in cycles.c) Microwaves cook direct heat and transfer.d) The power level buttons are about time not power.	<p>7. After the microwave turns off, molecules continue to cook food, so it's important to:</p> <ul style="list-style-type: none">a) convert electricity into a high voltageb) remove the foil covered tray or sleeve immediatelyc) puncture foods with high water content and firm skind) give foods resting or standing time
<p>3. Water, fat and sugar molecules vibrate very quickly creating lots of heat, and can cause:</p> <ul style="list-style-type: none">a) superheatingb) hot spotsc) conductiond) bacteria	<p>8. Erupting occurs when:</p> <ul style="list-style-type: none">a) tinfoil is used in microwavesb) a liquid is heated beyond its boiling pointc) plastic containers allow microwaves to pass throughd) a piece of metal creates sparks
<p>4. Smart buttons are:</p> <ul style="list-style-type: none">a) used to excite atomsb) heat conductorsc) pre-set buttons that cook popular foodsd) buttons that use the least amount of watts	<p>9. When you use the foil-lined sleeve to microwave your food, the sleeve:</p> <ul style="list-style-type: none">a) becomes hot and makes the outside crust brown and crispyb) causes foods with high water content to splitc) prevents hot spots in foods with high water contentd) causes waves to be converted into atomic motion
<p>5. Microwave power levels:</p> <ul style="list-style-type: none">a) have nothing to do with the strength of the wavesb) cook food without heatc) prevent arching and eruptingd) create the heat that cooks our foods	<p>10. Microwave energy does <u>not</u>:</p> <ul style="list-style-type: none">a) bounce off interior walls, floor, and doorb) feed into the cooking area where a fan helps disperse itc) pass through most glass, ceramic, and plasticsd) create a chemical reaction to cause browning

Microwave Mysteries

Multiple Choice Answer Key

<p>1. Microwave ovens do not use specific temperatures because they don't:</p> <ul style="list-style-type: none">a) <u>give off heat</u>b) use a transmitterc) stir or rotated) superheat foods	<p>6. In microwave ovens, the energy used to cook foods is measured in:</p> <ul style="list-style-type: none">a) full power wavesb) <u>watts of electricity</u>c) both Fahrenheit and Celsiusd) voltage
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<p>3. Water, fat and sugar molecules vibrate very quickly creating lots of heat, and can cause:</p> <ul style="list-style-type: none">a) superheatingb) <u>hot spots</u>c) conductiond) bacteria	<p>9. Erupting occurs when:</p> <ul style="list-style-type: none">a) tinfoil is used in microwavesb) <u>a liquid is heated beyond its boiling point</u>c) plastic containers allow microwaves to pass throughd) a piece of metal creates sparks
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Glossary of Terms

Arcing – Refers to the sparks created when microwaves react to metallic substances inside the oven. Sparks can damage the oven or start a fire.

Atomic Motion – The continual movement of molecules that occurs when heat accelerates atoms, causing them to break atomic bonds.

Celsius – A temperature scale in which water freezes at 100 degrees Celsius. A measurement of how hot something is that is also known as Centigrade.

Circuit – The path a current takes as it moves.

Conduction – The flow of thermal energy through a substance; a basic method of heat transfer that occurs by atomic or molecular interactions.

Cross-Contamination – Occurs when bacteria from one food item are transferred to another food item.

E. coli – Short for Escherichia coli, a bacterium present in the lower intestine of humans and warm-blooded animals that can cause a life-threatening gastrointestinal infection when it makes its way into food supplies.

Erupting – A liquid heated beyond its boiling point that violently boils over when removed from the microwave is said to be erupting. This sometimes occurs when a hot spot located an inch or so below the surface of a liquid is overheated.

Exciting – To raise a molecule to a higher energy level.

FDA – The **F**ood and **D**rug **A**dministration is the agency responsible for regulating and supervising the safety of foods, drugs and cosmetics.

Fahrenheit – A temperature scale in which water freezes at 32 degrees Fahrenheit. A measurement of how hot something is.

Magnetron – Machine that creates radio wave signals used in radar and microwave ovens.

Magnetron Tubes – Converts high voltage electricity into very short waves of electromagnetic (or microwave) energy.

Microwave Energy – Very short waves of electromagnetic energy.

Microwave Oven – An oven that cooks food using short radio waves, or microwaves.

Microwaves – Radio waves that operate at an approximate frequency of 2,500 megahertz (2.5 gigahertz). Microwaves are absorbed by water, fats and sugars, but are not absorbed by most plastics, glass or ceramics.

Molecules – The smallest particle of a substance that has all of the physical and chemical properties of that substance; molecules are made up of one or more atoms.

Radar – **RA**dio **D**etection **A**nd **R**anging. A system that uses a transmitter to emit radio waves called microwaves.

Radiation – Energy that travels outward in straight lines in all directions from the source.

Radio Wave Signal – Current or field used to convey data from one place to another.

Standing Time – The time after a microwave oven has been turned off, but during which time food continues to cook, as molecules continue to vibrate and generate heat as they come to a standstill. Also called *resting time* and *carryover cooking time*.

Superheating – Occurs when water heats past the boiling point (212 degrees Fahrenheit; 100 degrees Celsius), which is faster than vapor bubbles can form. In this condition, the water is very volatile, and even a slight disturbance such as bumping the cup, can cause the water to erupt.

USDA – **U**nited **S**tates **D**epartment of **A**griculture is the agency responsible for keeping the food sources safe.

Volt – A measure of the strength of the electric current.

Watts – A measurement of electrical power; a unit of electrical measurement equal to the current of one ampere produced by the electromotive force of one volt.

Additional Resources

FDA

<http://www.fda.gov/cdrh/consumer/erupted.html>

Food Safety

<http://www.foodsafety.gov/~fsg/fs-mwave.html>

Health Physics Society

<http://www.hps.org/hpspublications/articles/microwaveoven.html>

How Stuff Works

<http://home.howstuffworks.com/microwave.htm>

Microwave Guides

<http://microwaves.cookery-guide.info/choosing-microwave.php>

<http://wellnessways.aces.illinois.edu/pdf/Microwave/Microwave%20Cooking-Teacher's%20Guide.pdf>

Microwave Handbook

<http://www.utextension.utk.edu/publications/spfiles/sp493.pdf>

USDA

http://www.fsis.usda.gov/factsheets/Microwave_Ovens_and_Food_Safety/index.asp

<http://www.foodsafety.gov/~fsg/fs-mwave.html>

WebMD

<http://www.webmd.com/news/20070124/microwave-kills-germs-sponges>