Slide A

Interactions with Water

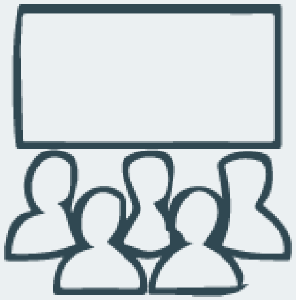
Turn and Talk

How does electromagnetic radiation interact with water in a microwave oven?

What evidence do we have for this interaction?

Slide B

Other Matter Interactions



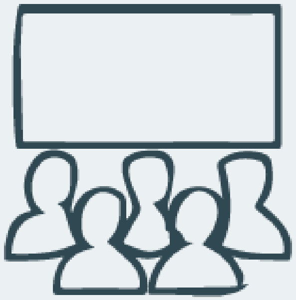
With your class

Does every substance that we put in the microwave oven absorb electromagnetic radiation just like water does?

What evidence do we have for this?

Slide C

Other Matter Interactions



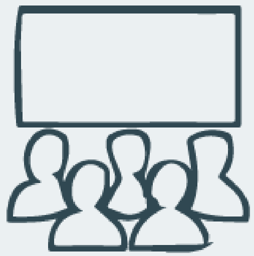
With your class

What makes the matter in water different from the matter in substances that do **not** heat up in the microwave oven?

On what scale should we investigate the matter to get a better idea about how these substances might be different from each other?

Slide D

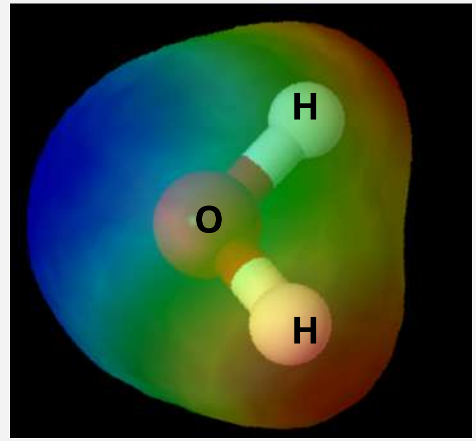
Zooming In on the Matter



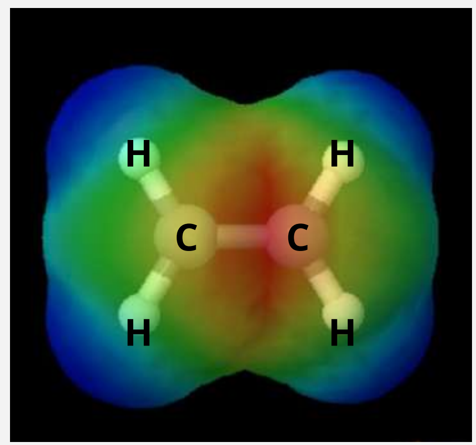
With your class

What do you notice about these models?

How is the matter similar? How is it different?



Water molecule



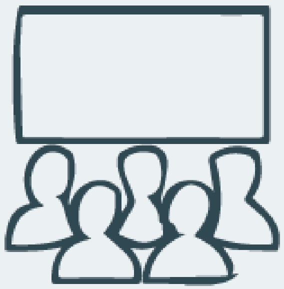
Microwave-safe plastic (ethylene) molecule

Adapted from: Jmol

More (more -)

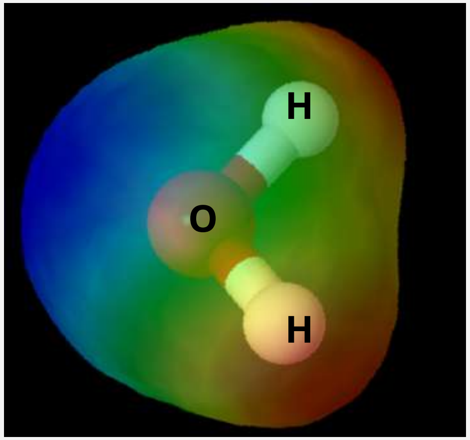
Fewer (more +)

Zooming In on the Matter

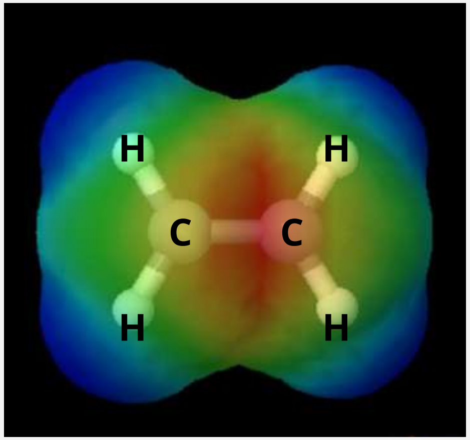


With your class

How do you predict the charge (+ or –) will be distributed in each of these molecules?



Water molecule



Microwave-safe plastic (ethylene) molecule

Adapted from: Jmol

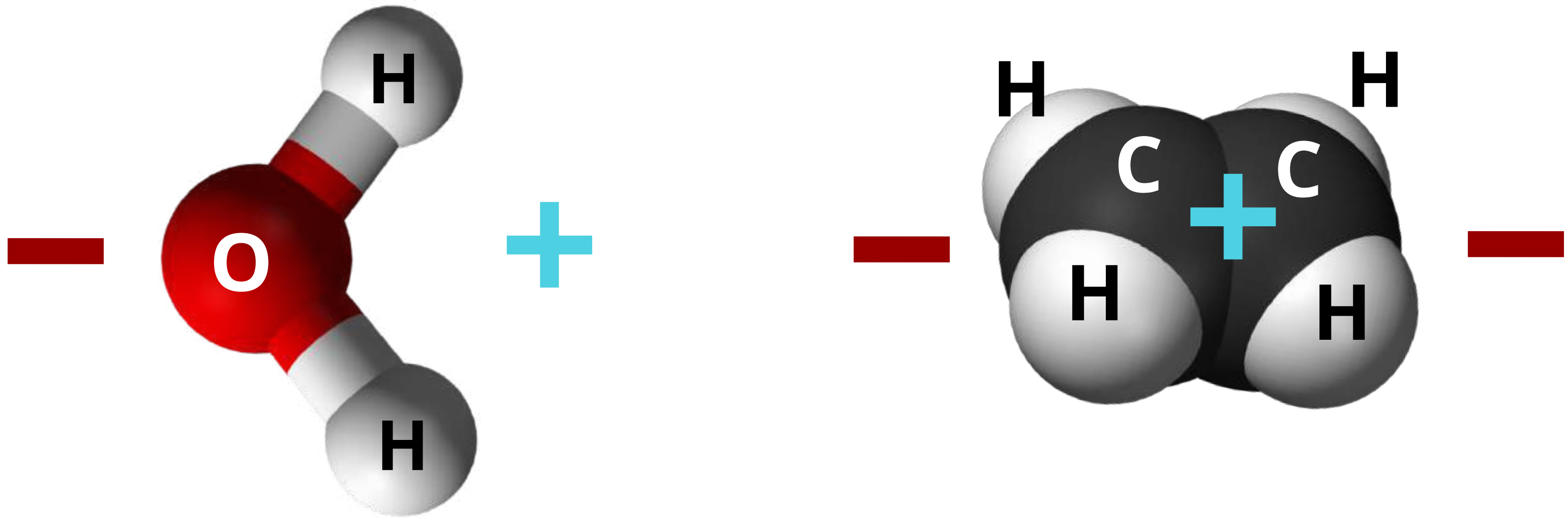
More (more -) | **Electron density** | Fewer (more +)

Slide F

Make an Inference

Turn and Talk

Given what we know about EM radiation and electric fields, how do you predict each particle would behave in a microwave oven?



Adapted from: Ben Mills

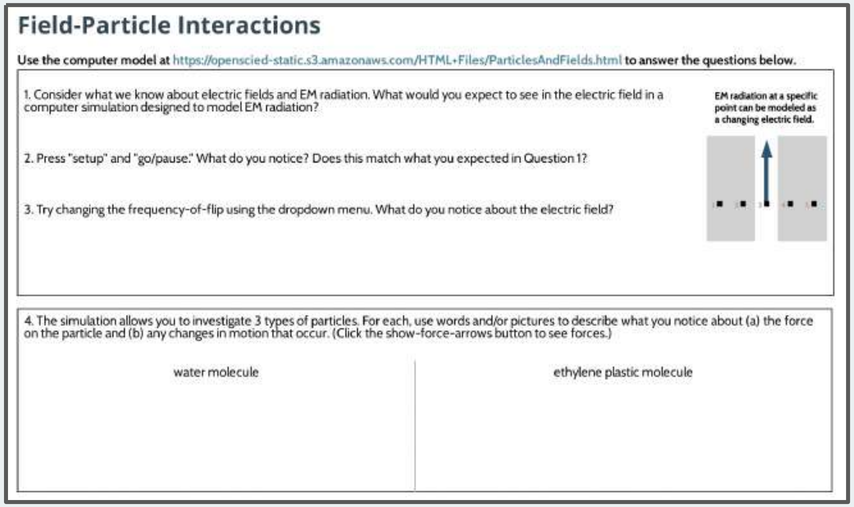
Slide G

Investigate a Computer Model

With your group

Make observations in a computer model of a changing electric field to explain changes in matter when EM radiation:

- absorbs into matter
- transmits through matter
- reflects off of matter



Field-Particle Interactions

Use the computer model at https://openscied-static.s3.amazonaws.com/HTML+Files/ParticlesAndFields.html **to answer the questions below.**

1. Consider what we know about electric fields and EM radiation. What would you expect to see in the electric field in a computer simulation designed to model EM radiation?

2. Press "setup" and "go/pause." What do you notice? Does this match what you expected in Question 1?

3. Try changing the frequency-of-flip using the dropdown menu. What do you notice about the electric field?

EM radiation at a specific point can be modeled as a changing electric field.

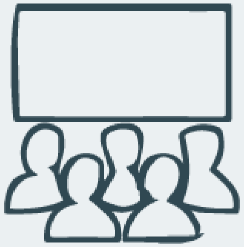
4. The simulation allows you to investigate 3 types of particles. For each, use words and/or pictures to describe what you notice about (a) the force on the particle and (b) any changes in motion that occur. (Click the show-force-arrows button to see forces.)

water molecule	ethylene plastic molecule

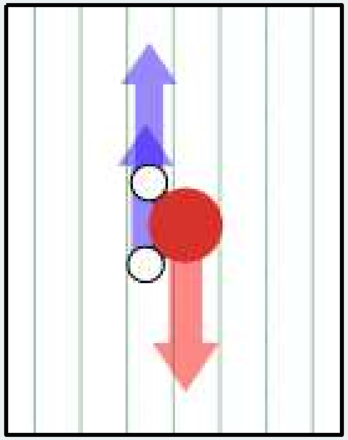
→ Be ready to share your ideas with the class.

Slide H

Explain Water in the Microwave Oven



With your class

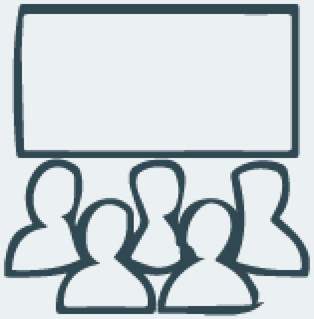


- What changes in the water molecule were caused by changing the field? Why?
- Do EM radiation waves absorb into, transmit through, or reflect off of the water? How do we know?
- How does this help explain some of the macroscopic changes we observed in our microwave oven experiments?

Wilensky, U. (1999). NetLogo. http://ccl.northwestern.edu/netlogo/. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

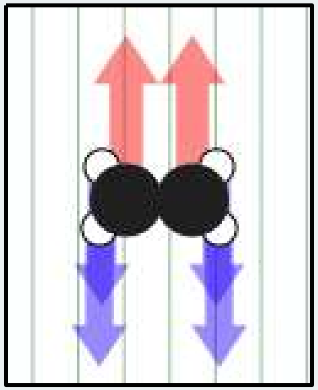
Slide I

Explain Plastic in the Microwave Oven



With your class

- How did the ethylene respond to the changing field? Why?



- Do EM radiation waves absorb into, transmit through, or reflect off of the ethylene? How do we know?
- How does this help explain some of the macroscopic changes we observed in our microwave oven experiments?

Wilensky, U. (1999). NetLogo. http://ccl.northwestern.edu/netlogo/. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

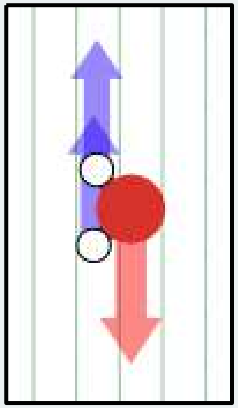
Slide J

Consider Differences in Frequency

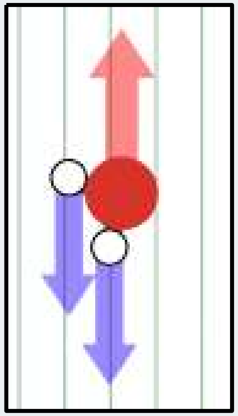
With your class

- What did you notice about how water molecules respond when we increase frequency?

lower frequency



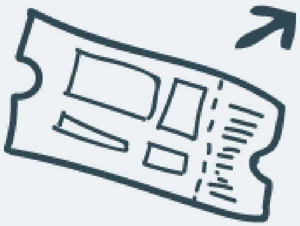
higher frequency



- We have seen in the past that higher frequency transfers more energy when amplitude stays the same. Does this agree with the new model we see in this simulation? Why or why not?

Wilensky, U. (1999). NetLogo. http://ccl.northwestern.edu/netlogo/. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

Exit Ticket



Exit Ticket

- On your handout, circle an explanation or drawing that clearly helps explain:

A. *Why does water heat up in the microwave oven?*

B. *Why doesn't the microwave-safe plastic heat up in the microwave oven?*

- If you don't have something yet, sketch a quick model to show ideas about why some substances heat up in the microwave oven while others don't. Show key components, such as:
  - **fields**
  - **charges**
  - **interactions**
  - **forces**

Slide L

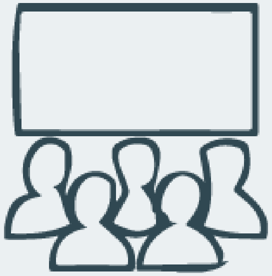
Navigation

With a partner

- Compare sketches on our exit ticket from last class with a partner.
- Brainstorm key components we would need in a consensus model to clearly explain:
  - *Why water heats up in the microwave oven.*
  - *Why the microwave-safe plastic does not heat up in the microwave oven.*
- Write your ideas in your science notebook.

Slide M

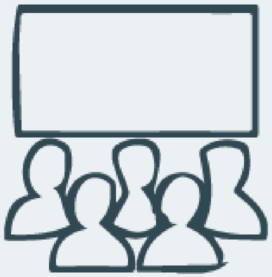
Develop a Consensus Model



With your class

What key components will we need in our consensus model?

Develop a Consensus Model

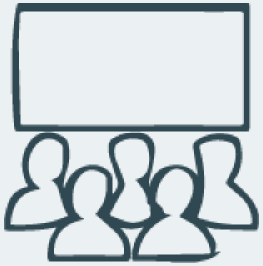


With your class

- What changes or interactions between these components do we need to show?
- What connection to macroscopic evidence are we trying to explain?

Slide O

Testing Our Model

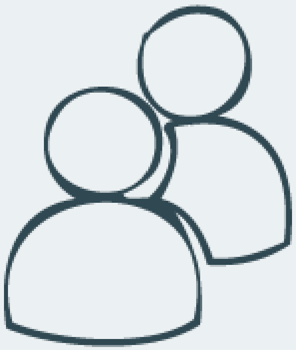


With your class

- Can our model help explain why aluminum foil is safer to use in the microwave oven under certain conditions but dangerous in others?
- What other products have you seen with metal in them that are designed to go in the microwave oven?

Slide P

Evaluate Information



With a partner

Read through each row of the Evaluating Information Checklist with a partner.

- Which categories do you think will be easy to identify from an article?
- Which categories do you think will be more difficult?
- Why do you think that?

→ Be ready to share your ideas with the class.

Evaluate Validity and Reliability of Claims

With your class

Read the following paragraph:

> “When you use a microwave oven, radiation passes through materials like paper, glass, and plastic, but it gets absorbed by the water content in food. The radiation makes the water molecules inside the food wiggle around, which creates heat and cooks the food.”

- Use the Evaluating Information Checklist to determine the *validity* and *reliability* of the claims in the paragraph.

Slide R

Evaluate Validity and Reliability of Claims

With a partner

- Use the Evaluating Information Checklist to evaluate the validity and reliability of the reading.
- Use ✔ or ✘ or **?** if you're not sure.
- Use each strategy in italics to help you decide.

Example	**Source:**	**1**	**2**
Valid: *Valid* claims are supported by evidence and consistent with scientific ideas.	Does the author back up their claims with evidence? *Underline sections where the author presents evidence.*	✘	
	Are the claims consistent with your own experiences and understanding? *List relevant experiences you've had, or relevant terms you understand.*	✔	
	Are the claims consistent with science ideas we have figured out in class? *Using a different color, underline the science ideas that each author is using to support their claim(s).*	✔	

Consider Why This Matters

On your own

Based on your evaluation, are the claims made in the reading:

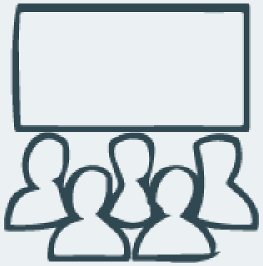
- ○ reliable?
- ○ valid?

→ Be ready to share your ideas with the class.

- Explain your answers, using details from the Evaluating Information Checklist and the reading.
- Why is it important to pay attention to the **validity** and **reliability** of the claims we read?

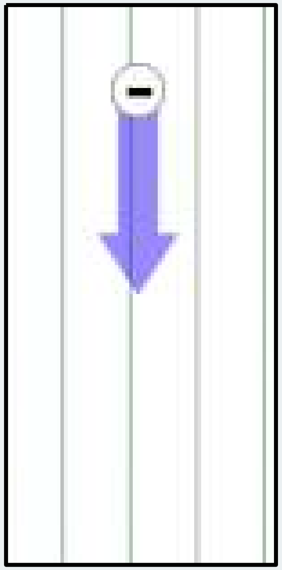
Slide T

Consider Aluminum Particle Structure



With your class

- How could we use the simulation of electrons in aluminum to verify claims made in the readings?
- What do you notice when we run the simulation of an electron?
- What do you notice when we run the simulation of electrons in aluminum?
- What does this tell us about the validity of claims in the readings?



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Personal Glossary and Progress Tracker

On your own

1. Use words and/or pictures to add your own definition for *polar molecule* to your Personal Glossary.
2. Make a record of your ideas right now in your Progress Tracker to explain why some materials heat up in the microwave oven and others do not.

Slide V

Navigate

Turn and Talk

Does our particle-scale model for what heats up and what stays cool in the microwave oven explain the patterns we observed of hot and cool spots when we heated nachos in the oven?

Licensing Information