Lesson 7: Why do some substances heat up faster than other materials in a microwave oven?

Interactions with Water

Turn and talk

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

2. What evidence do we have for this interaction?

Other Matter Interactions

With your class

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

4. What evidence do we have for this?

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

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

Zooming In on the Matter

With your class

7. What do you notice about these models? Reference slides for support.

8. How is the matter similar? How is it different?

9. How do you predict the charge (+ or -) will be distributed in each of these molecules? Reference slides for support.

Make an Inference

Turn and talk

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

Investigate a Computer Model

With your group

11. 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

Explain Water in the Microwave Oven

With your class

12. What changes in the water molecule were caused by changing the field? Why?

13. Do EM radiation waves absorb into, transmit through, or reflect off of the water? How do we know?

14. How does this help explain some of the macroscopic changes we observed in our microwave oven experiments?

Explain Plastic in the Microwave Oven

With your class

15. How did the ethylene respond to the changing field? Why?

16. Do EM radiation waves absorb into, transmit through, or reflect off of the ethylene? How do we know?

17. How does this help explain some of the macroscopic changes we observed in our microwave oven experiments?

Consider Differences in Frequency

With your class

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

19. 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?

Exit Ticket

On your own

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

- Why does water heat up in the microwave oven?
- Why doesn't the microwave-safe plastic heat up in the microwave oven?

21. 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

Navigation

With a partner

22. Compare sketches on our exit ticket from last class with a partner.

23. Brainstorm key components we would need in a consensus model that clearly explain:

- Why water heats up in the microwave oven.
- Why the microwave-safe plastic does not heat up in the microwave oven.

24. Write your ideas in your science notebook.

Develop a Consensus Model

With your class

25. What key components will we need in our consensus model?

26. What changes or interactions between these components do we need to show?

27. What connection to macroscopic evidence are we trying to explain?

Testing Our Model

With your class

28. Can our model help explain why aluminum foil is safer to use in the microwave oven under certain conditions but dangerous in others?

29. What other products have you seen with metal in them that are designed to go in the microwave oven?

Evaluate Information

With a partner

30. 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?

Evaluate Validity and Reliability of Claims

With your class

31. 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."

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

With a partner

33. Use the *Evaluating Information Checklist* to evaluate the validity and reliability of the reading.

34. Use ✔ or ✘ or **?** if you're not sure.

35. Use each strategy in italics to help you decide. Reference slides for support.

Consider Why This Matters

On your own

36. Based on your evaluation, are the claims made in the reading:
    - reliable?
    - valid?

37. Explain your answers using details from the *Evaluating Information Checklist* and the reading.

38. Why is it important to pay attention to the **validity** and **reliability** of the claims we read?

Consider Aluminum Particle Structure

With your class

39. How could we use the simulation of electrons in aluminum to verify claims made in the readings?

40. What do you notice when we run the simulation of an electron?

41. What do you notice when we run the simulation of electrons in aluminum?

42. What does this tell us about the validity of claims in the readings?

Personal Glossary and *Progress Tracker*

On your own

43. Use words and/or pictures to add your own definition for *polar molecule* to your Personal Glossary.

44. 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.

Navigate

Turn and talk

45. 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?