WARNING

This lesson requires the use of a microwave oven, which can pose safety risks when used improperly. Before teaching this lesson, please review the safety precautions in the front matter, reference materials, and *Teacher Guide* for setting up and running each investigation, as well as taking down, disposing of, and storing materials.

Navigate

Turn and Talk

- What did you predict the EM radiation would do when it encounters different types of matter that we might put in the microwave oven?
- How is your model similar to or different from your partner's model?

➔ Be ready to share your ideas with the class!

Slide B

Consider Other Known Waves

Individual Think Time

What is an example (in our room) of ...

- ... visible light being absorbed by matter?
- ... visible light reflecting (bouncing) off of matter?
- ... visible light transmitting through matter?

➔ Be ready to share your ideas with the class!

Consider Other Known Waves

With your class

Let's work together to create models of absorption, reflection, and transmission.

Add the models to our class chart.

Slide D

Consider Interactions Inside Microwave Oven

Turn and Talk

What types of materials are part of the microwave oven system (when it's in use)?

How do we think the microwave radiation is interacting with these different materials?

Energy of a wave = reflected + absorbed + transmitted

Consider Other Known Waves

With your class

What types of materials are part of the microwave oven system (when it's in use)?

Do we think microwave radiation interacts with these materials the same way light does?

Energy of a wave = reflected + absorbed + transmitted

➔ Be ready to share your ideas with the class!

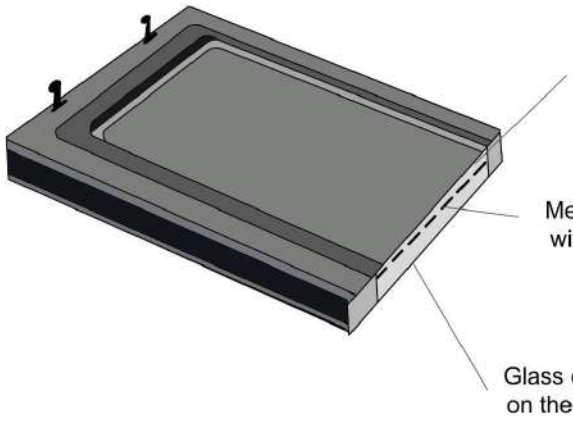
Analyze the Structure of the Window

With your class

- What types of materials is this structure made of?

- What material might represent the mesh?

- Does microwave radiation interact with these materials the same way light does?



Matter/Wave Interaction Consensus

With your class

What material interactions do we disagree on?

Where do we need more evidence to explain what is occurring when the waves interact with these materials?

Revise Your Model

All waves interact with matter in 3 different ways:

Energy of a wave = reflected + absorbed + transmitted

On your own

Revise your model and show how you think microwave radiation is interacting with all the different materials in the microwave oven system.

Navigate

On your own

Record in your science notebook:

What question(s) best captures what we are trying to figure out about the materials we were uncertain about?

➔ Be ready to share your ideas with the class!

Navigate

With a partner

Review your notebook:

What question(s) best capture what we are trying to figure out about the materials we were uncertain about?

➔ Be ready to share with the class!

Determine a Known Absorber

With your class

- How have we detected the absorption of microwave radiation so far?
- Do we have a way of knowing if these non-visible waves are being reflected or transmitted by the walls or door of the microwave oven?

Energy of a wave = reflected + absorbed + transmitted

Determine a Known Absorber

With your class

- How could we detect where the waves go?
- What material do we have that shows a clear interaction with microwave radiation?

Energy of a wave = reflected + absorbed + transmitted

Consider Safety Protocols

With your class

- How can we can safely use our microwave oven with something like metal in it?
- What safety concerns do we have, and how could we address them?

Consider Safety Protocols

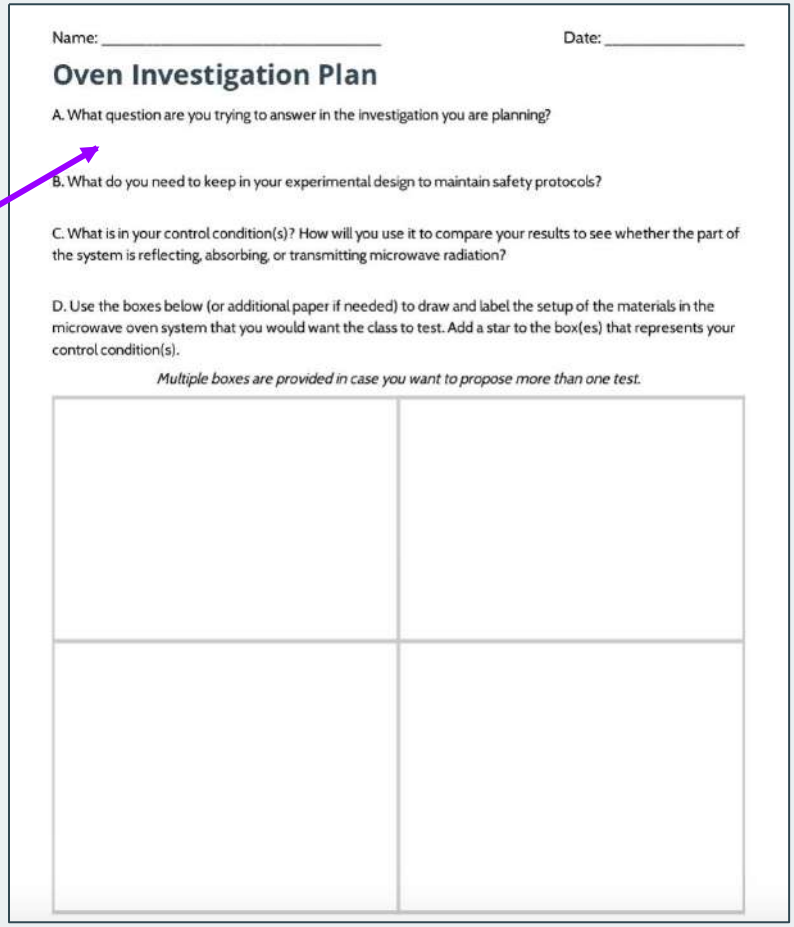
With your class

- Where could we find safety information about our microwave oven system?
- What safety considerations should we keep in mind and what protocols should we have in place when designing our investigations?

Plan an Investigation

On your own

Record your question in Part A at the top of your handout.



Name: _____ Date: _____

Oven Investigation Plan

A. What question are you trying to answer in the investigation you are planning?

B. What do you need to keep in your experimental design to maintain safety protocols?

C. What is in your control condition(s)? How will you use it to compare your results to see whether the part of the system is reflecting, absorbing, or transmitting microwave radiation?

D. Use the boxes below (or additional paper if needed) to draw and label the setup of the materials in the microwave oven system that you would want the class to test. Add a star to the box(es) that represents your control condition(s).

Multiple boxes are provided in case you want to propose more than one test.

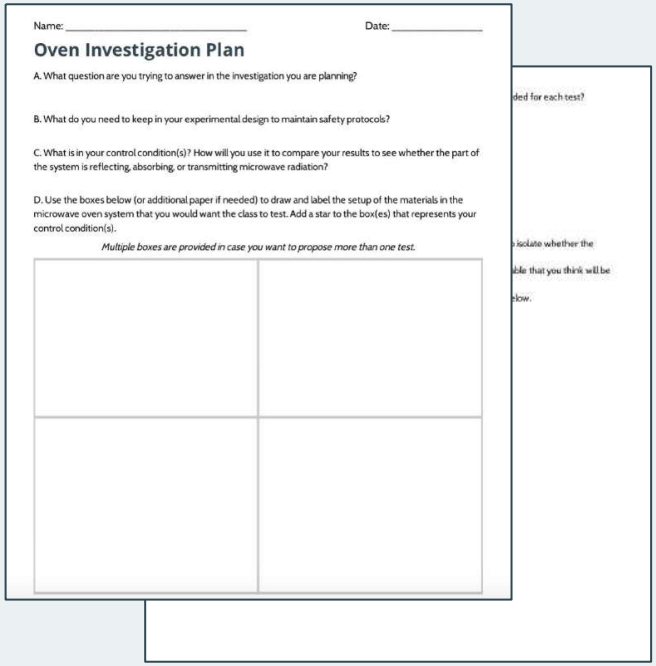
Plan an Investigation

With your group

Talk with your group.

Use the handout to record your ideas for how to investigate this question.

Make sure your plan follows our safety guidelines and can be used by the whole class to gather the information we need.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Multiple boxes are provided in case you want to propose more than one test.

➔ Be ready to propose your plan to the class!

Develop a Control Condition Plan

With your class

If we put foil around a bowl of water and observe temperature changes, how can we tell...

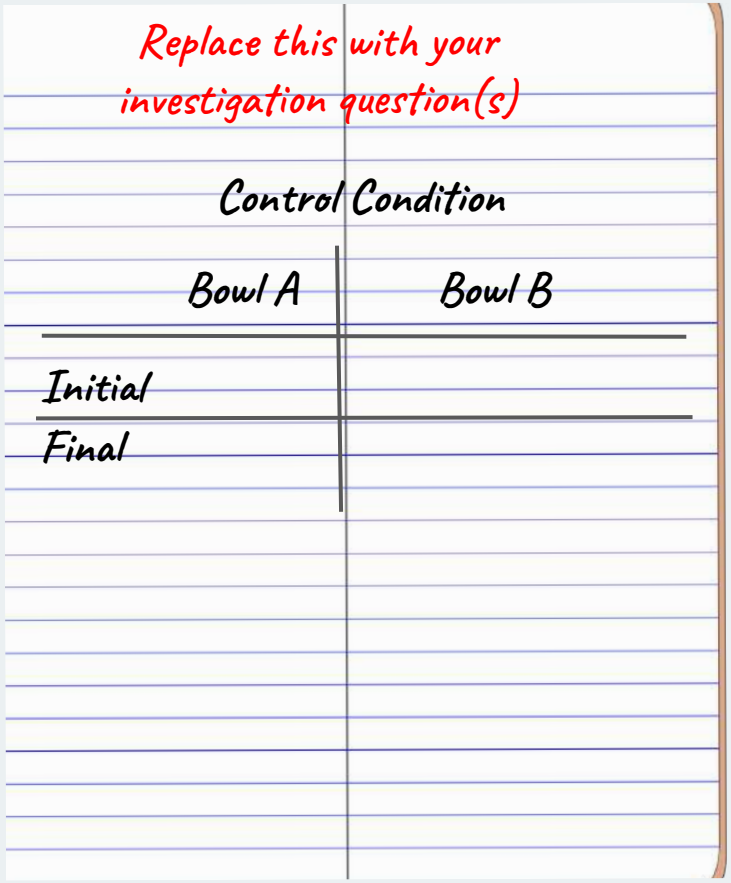
- ... whether these changes were caused by the foil and not something else?
- ... how significant the role of the foil was in changing energy transfer in the system?
- ... whether the foil absorbs, reflects, or transmits microwave radiation?

What additional experiment(s) would enable us to better answer these questions?

Set Up Science Notebooks

In your notebook

Let's prepare our notebooks to record our data from the investigation.



Argue for an Investigation Plan

With your class

- Make an argument for an investigation plan that meets our safety guidelines **and** that we could carry out together as a class.
- Respectfully provide and/or receive critiques on these plans by seeking clarification, probing reasoning, challenging ideas, and responding thoughtfully to alternate approaches that are proposed.

Argue for an Investigation Plan

Talk moves to use as presenter or audience:

- "I think I hear you saying ... Is that what you meant?"
- "What do you mean by ...?"
- "Do others have a similar idea?"
- "Do you have an alternate suggestion or a revision to this idea that you would like to propose?"
- "I agree/disagree with the idea of doing ... because ..."

Nonverbal feedback:

- Snap if you agree. Raise your hand if you have something to add.

Determine the First Investigation

We now have 2 different investigations outlined. The investigations are based around how EM radiation interacts with the walls and door of the microwave oven system.

Individual Think Time

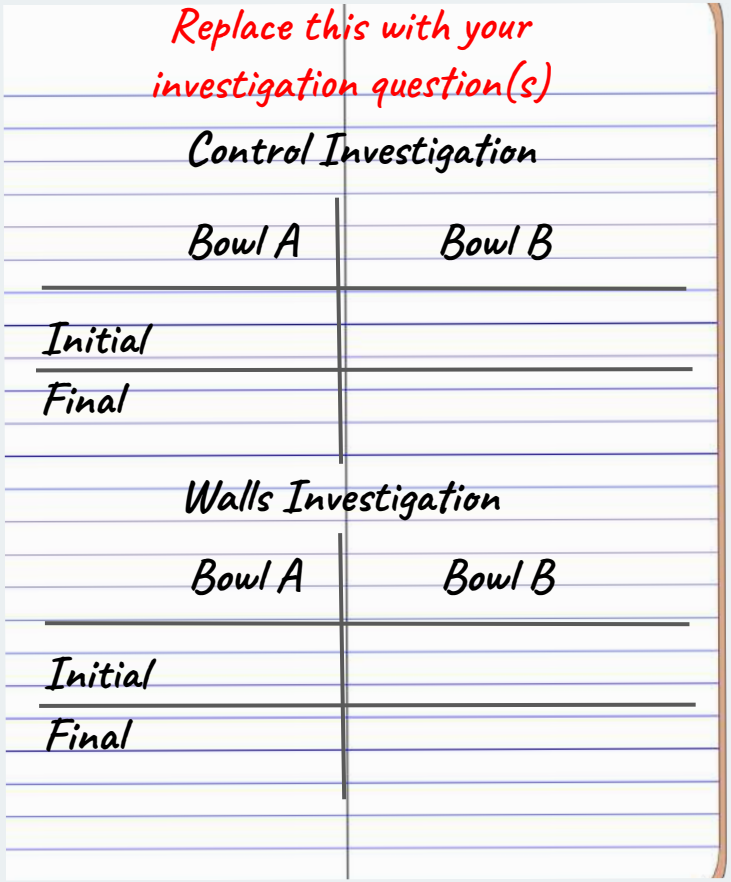
- Look back at what you wrote in Part E of your investigation plan handout.
- Do you feel more certain about your predictions for one investigation versus the other? Why or why not?

→ Be ready to share your ideas with the class!

Carry Out an Investigation (Wall)

With your class

- Create another table in your notebook and record your initial data.
- Carry out the investigation plan for the microwave walls.
- Record the final data for the wall test.



Consider the Impact of the New Data

We have data showing how EM radiation interacts with the solid foil that represents the walls of our microwave oven.

Individual Think Time

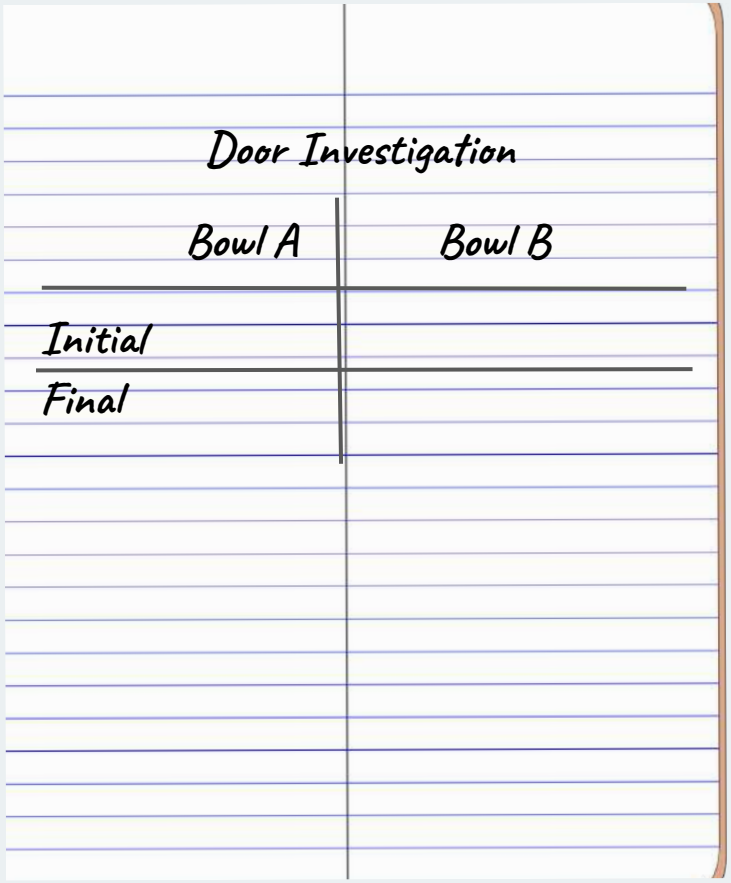
Based on our new data, how do you think the EM radiation will interact with the hole-punched foil?

➔ Be ready to share your ideas with the class!

Carry Out an Investigation (Door)

With your class

- Create another table in your notebook and record your initial data.
- Carry out the investigation plan for the microwave door.
- Record the final data for the door test.



Develop an Energy Transfer Model: Control

With your class

How can we model what happens to cause the water to warm up in our control condition?

Let's create a model to answer this question:

- Where did the energy in the system come from to increase the temperature of the matter in our control condition?

Revise a Model

On your own

Add, remove, or change the components and interactions in our class model for the control condition to explain our results with either the solid **or** the hole-punched foil.

Evaluate a Model

With a partner

Stand up, find a partner, and use your models to consider the following question:

- How do the matter-and-energy interactions represented in both of your models compare?

Update Your Progress Tracker

On your own

- Make a record in your Progress Tracker of your ideas right now for explaining how the materials that make up the walls and door of the microwave oven interact with microwave radiation.

Ask Questions

On your own

- *Write 1 question per sticky note.*
- *Write in marker--big and bold.*
- *Put your initials on the back in pencil.*

- What new question(s) did this lesson raise for you?
- What remaining question(s) do you have about different materials and matter-and-energy interactions from our EM Radiation Interactions Chart or DQB?

➔ Save these sticky notes in your notebook to share next class period.

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