

**Why do we
sometimes
see different
things when
looking at the
same object?**



MIDDLE SCHOOL SCIENCE



FIELD TEST
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Why do we sometimes see different things when looking at the same object?

One-Way Mirror





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One-Way Mirror

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Student Procedures



Lesson 1: How can something act like a mirror and a window at the same time?

Explore an Interesting Phenomenon

In your notebook



1. Make a chart on a blank left-side page in your science notebook to record what you notice and wonder about.

Notice	Wonder

2. Watch the video closely and record what you notice and wonder.

Share Noticings and Wonderings

With your class



3. Share what you noticed and wondered with your class.

- What did you notice happening in the video?
- What did you wonder about?

What do we think is happening?

Turn and talk



4. Discuss these questions:

- Why do the men see Mr. Bean?
- Why does Mr. Bean see himself and not the men?

Initial Explanations

With your class



5. Discuss the “parts” or “components” of the scene in the video:

- What parts are important for explaining the phenomenon?
- What parts are not important?
- What parts are we not certain about?

Develop a Diagram

In your
notebook



6. Write these two questions in your notebook:
 - Why do the men see Mr. Bean?
 - Why does Mr. Bean see himself and not the men?
7. Create a diagram to explain as much as you know about the two questions.
 - Include all the important parts and label them.
 - Use pictures, symbols, and words to explain **how the parts interact** to cause the phenomenon.
 - Record questions that you have if you become stuck.

Compare Diagrams

With a partner



8. Each partner shares their diagram. When it is your turn, turn your science notebook around so your diagram faces your partner.
9. As you notice things about each diagram, record the following:
 - Place a ✓ by parts of your diagrams that are similar.
 - Place a ? by parts of your diagrams that are different or where you are less certain.

Navigation

With your class



10. If we want to investigate the phenomenon using a scale model, what important parts do we need to include in the scale model?

Navigation

A scale model is a physical representation of something in the world. It can help us explain phenomena or solve problems.

With your class



11. Discuss: Where have you seen or used scale models in your life?

Mapping the Model to the _____

Physical models are useful for studying the real world and testing our ideas about phenomena. The physical model is one way to represent the important parts and interactions from the real world.

With your class



12. Work with your class to map parts of the box model to the parts they represent from the video.
 - How are the parts alike?
 - How are the parts not alike?

Investigate Using the Box Model

In your
notebook



13. Locate your Notice and Wonder chart.
14. Draw a line below your last noticing from the video. Below this line you will add noticings from the *Box Model Investigation*.

With your
group



15. Turn on the flashlight for Room A.
16. Peek through the viewing hole for Room A. Record noticings to your Notice and Wonder chart.
17. Peek through the viewing hole for Room B. Record noticings.
18. Turn off the flashlight.
19. Add wonderings to your chart.
20. If time allows, remove Room A from the box model.

Noticings from the Box Model Investigation

In your
notebook



21. Review the *Communicating in Scientific Ways* sentence starters. Which ones may be helpful for sharing observations?
22. Tape the sentence starters into your notebook as directed by your teacher.

With your class



23. Discuss with your class:
 - What was similar between what you saw in the video and what you saw in the box model?
 - What was different?
 - What new things did you notice in the box model?
24. Record additional noticings and wonderings to our class chart.

Limitations of the Box Model

Models are useful for representing the real world to explain phenomena. But models are not a perfect representation.

With your class



25. Discuss: If we use this box model to test ideas about the one-way mirror phenomenon, what *differences* between the box model and the real world shown in the video could be important to keep in mind?

Exit Ticket



26. Look at your Notice and Wonder chart and your diagram. Complete the following exit ticket.
- What is one idea you want to bring to our whole-class discussion next time to help us explain the phenomenon?
27. Give your exit ticket to your teacher before you leave class.

Classroom Norms

Norms are best practices that we all agree to try to work on so we have a productive and respectful learning environment. Norms are similar to rules but are more about how we communicate and work together as a learning community.

Scientists Circle 28. Work with the class to discuss norms that will be useful for our work together.



Purpose of Our Consensus Discussion

The goal of this discussion is to figure out areas of agreement and disagreement in our diagrams. We also want to practice our norms.

Scientists Circle 29. Our discussion is guided by these questions:



- What do we all seem to agree on?
- What do we disagree on?
- What are some new ideas that we may want to consider?

Initial Class Consensus Model to Explain the Phenomenon

A diagrammatic model is another way to represent and explain a phenomenon in the real world. This kind of model should capture your thinking using pictures, symbols, words, and colors to explain the phenomenon. Your goal is not to draw the real world, but rather to explain how the phenomenon works.

Scientists Circle 30. Develop a model with your class to answer the following questions:



- Why does Mr. Bean see himself but not the men?
- Why do the men see Mr. Bean but not themselves?

Brainstorm Related Phenomena

Turn and talk



31. Discuss: What other experiences have you had, or objects have you seen, that the video and the box model remind you of?

Scientists Circle



32. Work with your class to create a list of Related Phenomena that you believe are similar to the one-way mirror phenomenon.

Home Learning: Self-Documentation

Our phenomenon is an object that looks different in different conditions. Where do you see a similar thing in your life? Your home? Your neighborhood or community?

Home learning



33. Take a photo or hand-draw one example of a related phenomenon from your life.
34. Bring your example to class to build a set of related phenomena.

Types of Questions to Ask

On your own



35. All questions are welcomed! As you write your question(s), ask yourself:
- If we answer this question, will it help us explain the phenomenon?
 - Can we investigate this question to learn more?
 - Can it be answered with a yes or no? If so, can I write it in a different way?

What questions do you have now?

On your own



36. Review these items to find questions that you have about the phenomena :
- your Notice and Wonder chart and initial models,
 - our Initial Class Consensus Model, and
 - our list of Related Phenomena.
37. Then, write one question per sticky note in big, bold, and clearly readable handwriting.
38. Put your initials on the back of the sticky note in pencil.

Driving Question Board (DQB)

Scientists Circle



39. How to build a Driving Question Board:

1. The first student reads their question, then posts it to the DQB.
2. Students should raise their hand if one of their questions relates to the question that was just read aloud.
3. The first student selects the next student whose hand is raised.
4. The second student reads their question, says why or how it relates, and posts it near the question it most relates to.
5. The student selects the next student, who may have a related question or a new question.
6. We will continue until everyone has at least one question on the DQB.

Systems Thinking

When scientists try to develop an explanation for something that happens in the world, they often start by

- identifying the important parts,
- investigating the ways the parts may be interacting, and
- setting a boundary on what's important (carving out the part of the world they want to investigate and explain).

This type of thinking is called **systems thinking**.

With your class



40. Discuss: When have we done this kind of thinking already?

Ideas for Investigations

Turn and talk



41. Your teacher will assign one group of similar questions for your group to work on.
42. What kinds of investigations could we do to answer this set of questions? What additional sources of data or information might we need?

Scientists Circle



43. Share your ideas for investigations with your class to develop a class list.

Lesson 2: What happens if we change the light?

Home Learning: Self-Documentation

Home learning



1. Phenomenon: An object, like the one-way mirror, looks different in different conditions. Continue documenting examples of related phenomena.
 - Where do you see a similar thing in your life? your home? your neighborhood or community?
 - Take a photo or hand-draw one example.
 - Bring your example to class to build a set of related phenomena.

Navigation

Inside the box model, the one-way mirror looks like a mirror from one side and a window from the other side.

With your class



2. Discuss: If we take the one-way mirror out of the box model, what do you think we'll observe?

Observe the One-way Mirror

With your group



3. Slide the one-way mirror out of the box model. Make observations of the material.

With your class



4. Discuss these questions:

- What did you observe?
- How is this similar to, and different from, what you observed when the one-way mirror was in the box model?

What would happen if we change the light?

On our DQB, we have a lot of questions about whether light causes the one-way mirror effect. We think that having light on one side matters.

With your class



5. Discuss: If we move the light to the other side of the box model and make observations, how would that help us support our claim that having light on one side is important for the one-way mirror effect?

Light Swap Investigation

With your group



With your class



Revisit Related Phenomena

We know this phenomenon we are seeing has something to do with the difference between the amount of light on the two sides of the one-way mirror.

With your class



8. Discuss: What related phenomena have to do with a light difference?

Testable Questions about Changing the Light

With your class



9. What other questions on our DQB about changing the light could we test right here and right now in the classroom?

10. Consider what is feasible:

- Do we have the supplies?
- Can we test it in the amount of time we have?

Prepare to Change the Light

We will use an additional flashlight and extra cardboard to investigate our new questions.

On your own



11. Complete #1 and #2 in Part A of *Testing Light Scenarios* for one of the following two questions, as assigned by your teacher:

- What would happen if it was light in both rooms?
- What would happen if it was dark in both rooms?

Testing Lighting Scenarios Investigation

Physical models are useful for studying the real world and testing our ideas about phenomena. A physical model is one way to represent the important parts and interactions from the real world.

With your group



12. Investigate your assigned question first.
13. Discuss and record what you observe in #3 in Part A of *Testing Light Scenarios*.
14. Investigate the other question. You do not need to complete Part A for this question.
15. In our next session, we'll share our observations and start to make sense of them.

Home Learning: Self-Documentation

Home learning



16. Phenomenon: An object, like the one-way mirror, looks different in different conditions. Document examples of related phenomena.
 - Where do you see a similar thing in your life? your home? your neighborhood or community?
 - Take a photo or hand-draw one example.
 - Bring your example to class to build a set of related phenomena.

Make Sense of the Testing Lighting Scenarios Investigation

We are trying to figure out: What happens if we change the light?

The new scenarios we tested are evidence that could help us explain what might be happening with the Mr. Bean phenomenon. Our initial consensus ideas about what was happening with the Mr. Bean phenomenon and the role of light might help us explain these new scenarios.

With your group



17. Complete Part B of *Testing Light Scenarios* for your assigned question.

Norms: Idea Pirating

What happens if we change the light?

Each group made sense of one of our questions. We will share and compare our ideas through a gallery walk.

With your class



18. Discuss with your class:

- Why would we want to share and compare our ideas?
- What norms can we focus on when we share and compare ideas?

Gallery Walk

Models are useful for representing the real world to explain phenomena. But models are not a perfect representation.

With your group



19. Place one handout on your desk to represent your group's thinking.
20. Visit at least one group who made sense of the other question.
21. Visit at least one group who made sense of the same question as you did.
22. Discuss what you notice in their models and explanations. How are they similar to your group? How are they different?

Building Understandings Discussion

Scientists Circle



23. What would happen if it was dark in both rooms?
 - What did you observe when you made this change?
 - What do you think was happening?
 - How did you represent what was happening?
24. What would happen if it was light in both rooms?
 - What did you observe when you made this change?
 - What do you think was happening?
 - How did you represent what was happening?
25. What happens when we change the light?
 - What do we agree about? What do we disagree about?
26. We may not all agree about why this is happening, but we can agree on what the arrows in our models should represent.
 - How are we currently using arrows? What do the arrows represent?
 - How could we all use arrows in the same way?

Tracking Our Ideas

A Progress Tracker is a way for us to track important ideas we've figured out.

In your notebook



27. Set up a Progress Tracker:
 - Reserve 10 pages in your science notebook after the table of contents for the Progress Tracker. At the top of the first page, record the unit driving question.
 - Draw a two-column chart below and label the left side "Question / Lesson #" and the right side "What I figured out".
28. Fill out the Progress Tracker for this lesson:
 - Record the lesson question and number in the left column.
 - Add ideas about what you figured out in the right column.

Our Driving Question: *Why do we sometimes see different things when looking at the same object?*

Question / Lesson #	What I figured out
<i>What happens when we change the light? (2)</i>	

Build a Self-Documentation Collection

Phenomenon: An object, like the one-way mirror, looks different in different conditions. Why do we sometimes see different things when looking at the same object?

Scientists Circle 29. Where do you see a similar thing in your life? your home? your neighborhood or community?



- Get out your photo or hand-drawn example to share with the class.

30. How to build a Self-Documentation Collection

1. The first student explains their related phenomenon image, then posts it to the board.
2. Students should raise their hand if their image relates to the image that was just shared.
3. The first student selects the next student whose hand is raised.
4. The second student shares their image, says why or how it relates, and posts it near the image it most relates to.
5. The student selects the next student, who may have a related image or a new image.
6. We will continue until everyone's image is on the board.

Thought Experiment

With your class 31. Discuss with the class:



- If we swapped the one-way mirror with a regular mirror, how would that change what Mr. Bean and the men saw?
- If we swapped the one-way mirror with regular glass, how would that change what Mr. Bean and the men saw?
- Why might light be doing something different with the one-way mirror compared to a regular mirror and glass?

Ideas for Investigation

With your class 32. Discuss: How could we investigate if using different materials would cause us to see different things?



Lesson 3: What happens when light shines on the one-way mirror?

Navigation

In the previous class period, we were curious about changing the material in the box model to see how it changes the phenomenon.

With your group



1. Quickly circulate to each box model and make observations of the new material inside each of them.
2. Make sure the light is turned on in Room A, and then make observations from both sides.
3. Quietly share your observations with your group.

Share Initial Observations

With your class



4. Share your observations of the different materials in the box model with the class.
 - What did we notice was similar or different between the glass, regular mirror, and one-way mirror inside the box models?
 - What do we think could cause these similarities or differences?

Setting Up Our Science Notebooks

In your notebook



5. Write the investigation question at the top of the next available page in your science notebook:
 - “What is light doing when it shines on the one-way mirror, glass, and a regular mirror?”
6. Then draw the chart on the slide. Leave room for observations.

Light Interactions Investigation

With your group



7. Shine the flashlight on each of the materials:
 - one-way mirror
 - glass
 - regular mirror
8. Document your observations in your notebook using pictures and words.
9. Be prepared to share with the class.

Building Understandings Discussion

With your class



10. Share your observations with the class.

- What did you observe when the light interacted with each material?
- What similarities and differences did you notice as you observed the materials interacting with light?

Draw Initial Conclusions

With your class



11. Discuss these questions:

- What have we figured out?
- How can we represent what we have figured out?

12. As a class, create a consensus model that shows how light interacts with each material.

Summarize and Next Steps

We know that light bounces off all three materials and that light goes through glass and the one-way mirror. What we don't know is how much light transmitted through or reflected off each material.

Turn and talk



13. Turn and talk to your partner about these questions:

- How might measuring the amount of light that transmits and reflects be important for explaining the one-way mirror phenomenon?
- How could we determine how much light transmits and reflects?

Develop an Experimental Question

Scientists develop questions that they can test to collect evidence about a phenomenon or problem. To develop these testable questions, scientists need to know what to observe or measure to answer their question.

With a partner



14. Begin with our original question: "How much light is reflected and how much is transmitted by each material?"

15. Use Part A in the *Asking Questions Tool - Experimental Questions* to help you and your partner develop a type of testable question called an experimental question, which can be used to guide our next investigation of the one-way mirror.

Navigation

In your notebook



16. Tape the *Asking Questions Tool - Experimental Questions* into your notebook and clean up for the day.

Navigation

We have described light interactions with a one-way mirror, glass, and a regular mirror using phrases such as “light bounces off” and “light passes through.” We have described what each phrase means using evidence from our investigations, so we can now use science words that mean the same thing.

With your class 17. Add the following words to the class Word Wall:



- Reflect - bounce off
- Transmit - pass through

Next Steps

With your class 18. Think about the *Light Interactions Investigation* we conducted during our last class period.



- What did we figure out when we shined light on the one-way mirror, glass, and regular mirror?
- What did we decide we needed to do next?

19. We will use a tool called a light meter to measure the amount of light reflected off and transmitted through each material.

Come to Consensus

With your class 20. We have worked with our partners to generate ideas for experimental questions that we can use to guide our next investigation. Let's come to consensus about what our question should be.



- What is the original question we wanted to investigate?
- What will cause an effect? (independent variable)
- What will we measure to see if the change we made has had an effect? (dependent variable)
- What experimental question did you and your partner develop?

21. After all groups have shared their experimental question, work together to select or revise one question for the class to use.

Planning the Investigation

With your class 22. Our experimental question has some important components that we need to think about in order to plan the investigation:



- What materials are we testing?
- What data will we collect?
- What must not change as we are conducting tests?

Using a Light Meter to Measure Reflected and Transmitted Light

A light meter detects light similarly to our eyes, and it can only detect light that directly enters the sensor area. It measures the amount of light in a unit called a lux. If we set the meter at medium sensitivity, a reading of “024” represents 24×10 lux or 240 lux.

With your class 23. Look at the *Template for the Measuring Light Investigation*.



- What light is detected by the light sensor in position 1?
- What light is detected by the light sensor in position 2?
- Why is the light sensor in these two different locations?
- Does this seem like it will get us the data we need to answer our experimental question? Why or why not?
- How will this template help us be more accurate in our measurements?

Making Predictions

On your own



24. Before you begin the investigation, take a few moments to individually predict what you think the light will do when it interacts with each material. Record your predictions in the chart on the *Measuring Light Investigation Procedures*.

Measuring Light Investigation Procedures

With your group



25. Follow the procedures in the *Measuring Light Investigation Procedures* to conduct the investigation.
26. When your group has completed the investigation, send one person to fill in your group data in the charts at the front of the room.
27. Tape the *Measuring Light Investigation Procedures* into your science notebook.
28. Collect and return all lab materials and equipment.

Navigation

We used a light meter to measure the amount of light reflected and transmitted by the one-way mirror, glass, and regular mirror. We recorded our group data in the class charts.

With your class 29. Discuss: What are we trying to figure out from this investigation?



Analyzing Class Data

In your notebook



30. Set up your science notebook to record what you notice as you analyze the class data.

- Title the next available page: "Analyzing Light Meter Data"
- Add two categories and leave space for recording your findings for each:
 - Light transmitted
 - Light reflected

With your group



31. With your group

- Look for patterns in the class data for the amount of light transmitted off each of the materials and document what you notice.
- Look for patterns in the class data for the amount of light reflected by each of the materials and document what you notice.

Consensus Discussion

The goal of this discussion is to compare how light interacts with the one-way mirror, glass, and regular mirror so we can try to explain the one-way mirror phenomenon.

Scientists Circle



32. Discuss these questions in a Scientists Circle:

- What patterns did you notice in the data?
- What did these patterns in the data and our observations help us figure out about how light interacts with these materials?
 - one-way mirror
 - glass
 - regular mirror
- How might we represent what we have figured out about these materials?

33. Work with the class to revise the class consensus model.

Update Progress Tracker

On your own



34. Draw a 2-column chart in the Progress Tracker section of your notebook.

35. Write the lesson question in the left column:

- "What happens when light shines on the one-way mirror?"

36. In the right column, use words and pictures to document what you have figured out in relation to the lesson question.

Revisit the Driving Question Board

With your class



37. What questions did we have about what the one-way mirror is made of?

- Look through the questions on the Driving Question Board.
- Identify the questions about what the one-way mirror is made of.

Navigation

With your class



38. What do we think the one-way mirror is made of that allows it to do different things with light?

Lesson 4: How do similar amounts of light transmit through and reflect off the one-way mirror?

Navigation

Turn and talk



1. Talk with a partner about the following questions:

- What did we learn about the one-way mirror from the *Measuring Light Investigation*?
- How was the amount of light reflected or transmitted different from glass and a regular mirror?
- What other information do we need to explain the observed patterns?

With your class



2. Share your ideas with your class.

Close Reading Strategies

On your own



3. Read a text that explains how a regular mirror is made compared to how a one-way mirror is made. Follow these strategies as you read the text.

1. Identify the question(s) you are trying to answer in the reading.
2. Read once for understanding to see what the reading is about.
3. Read a second time to highlight a few key ideas that help answer the questions you had.
4. Summarize the key idea(s) in your own words, in diagrams, or both.
5. Jot down new questions that this raises for you.

With a partner



5. Summarize the key ideas from the reading that can help you answer the question, "How do similar amounts of light transmit through and reflect off the one-way mirror?"
6. Model how 10 light rays interact with a mirror, a one-way mirror, and glass. Be prepared to share your model with the class.

Share New Information Learned

With your class



7. Share the key ideas you summarized that helped you start to answer our question:

How do similar amounts of light transmit through and reflect off the one-way mirror?

Modify Our Model

With your class



8. Work with your class to revise the class consensus model to explain how light transmits through and reflects off the three materials. Consider the following question:
 - a. What do we think is happening to light rays that shine on the different structures in these materials?
9. Compare the 10 light ray representation to the previous model you developed using dashed and dotted arrows.
 - a. How are they similar and different?
 - b. What are the benefits and limitations of the 10 light ray representation?
 - c. What are the benefits and limitations of the dashed/dotted arrow representation?
 - d. How can we take the best from each model and combine them?
10. Work with your class to develop a new model that uses ideas from the 10 light ray representation and the dashed/dotted arrow representation.

Add Science Ideas to Our Chart

With your class



11. Discuss with your class: What new information do we have now to answer our question?

How do similar amounts of light transmit through and reflect off the one-way mirror?
12. Add new science ideas to your class chart as you answer this question.

Navigation

Turn and talk



13. Discuss with a partner: How does the structure of the one-way mirror interact with light to cause the phenomenon?

Lesson 5: How do light and the one-way mirror interact to cause the one-way mirror phenomenon?

Revisit an Interesting Phenomenon

With your class



1. Watch the Mr. Bean video closely. Focus on these things:

- **What is seen?** Why does Mr. Bean see himself? Why do the men see Mr. Bean?
- **What is not seen?** Why can't Mr. Bean see the men?

2. Discuss these questions:

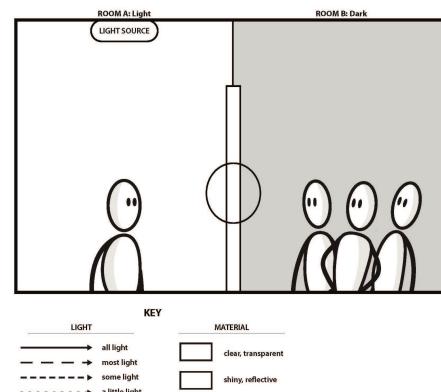
- **What is seen?** If we want to explain why Mr. Bean sees himself and the men can also see him, what do we need to include in our models?

Modeling

On your own



3. Using the diagram on *Why do Mr. Bean and the men all see Mr. Bean?*, model what happens to light as it leaves the light source to explain why Mr. Bean and the men all see Mr. Bean.



With your class



4. Share your models and come to consensus about the path light travels.
5. Light from the light source reaches Mr. Bean and then reflects off him. But that light from that light source is going all around the room to other objects too. To keep track of when light reflects off people or objects, add color to the arrows after they reflect off Mr. Bean.

Why doesn't Mr. Bean see the men?

The men are in a dark room, but it's not completely dark. They are still lit up a little. Why doesn't Mr. Bean see them?

Turn and talk



6. Discuss this question:

- Where is the light coming from that lights up the men?

With your class



7. Work with your class to model: What happens when light from the Room A light source shines directly on the one-way mirror toward the men?

With a partner



8. Work out your initial ideas about what happens to the light *after* it shines on the men, using pencil.

With your class



9. Share your models and come to consensus about the path light travels after it shines directly on the one-way mirror toward the men.
10. Add a new color to the arrows that reflect off the men.

Modify Our Model

With your class



11. Consider the light inputs entering Mr. Bean's eyes and the men's eyes.
Discuss the following questions:
 - What light is entering Mr. Bean's eyes?
 - If we zoomed in on just Mr. Bean's eyes, how could we represent these different amounts of light?
 - What light is entering the men's eyes?
12. Add zoomed-in eyes to the class model, showing the light inputs that enter Mr. Bean's and the men's eyes.

Navigation

Mr. Bean has two light inputs entering his eye:

1. some light that has reflected off Mr. Bean
2. a little light that has reflected off the men

With your class



13. Discuss these questions with your class:
 - What would we expect Mr. Bean to see, based on the light inputs to his eye?
 - What do you think could be happening?

Lesson 6: Why does Mr. Bean not see the men?

Navigation

Mr. Bean has 2 light inputs that enter his eyes:

- light that reflects off Mr. Bean to the one-way mirror and back to Mr. Bean's eyes
- light that reflects off the men and transmitted through the one-way mirror to Mr. Bean's eye

We know that the first light input is stronger than the second.

With a partner



1. Discuss:

- What did we expect Mr. Bean to see, based on the light inputs into his eye?
- What does he actually see?

Set Up Our Science Notebooks

We figured out why Mr. Bean can see himself, and why the men see him, but we have not figured out why Mr. Bean cannot see the men. If we can figure out why Mr. Bean can see one light input, we can use that to understand why he doesn't see the other one. So we need to further investigate what happens after a light input enters Mr. Bean's eye.

In your notebook



2. Write the investigation question at the top of the next available page in your notebook: "What happens to light after it enters Mr. Bean's eyes so that he can see himself?"
3. Draw a 2-column Notice and Wonder chart in your notebook.

Watch a Video

In your notebook



4. Watch the video, *The Visual System: How Your Eyes Work*.
5. As you watch, record what you notice and wonder in your chart.

Develop a Class Model

With your class



6. Share what you noticed and wondered as you watched the video.
7. Work with the class to develop a class model that
 - shows the path of light after it enters the eye, and
 - describes what happens from the time light enters the eye to the time the brain processes the signal.

Set Up Our Science Notebooks

In the video, we observed light coming together to a point as it passed through the lens of the eye. We haven't accounted for anything like this before. We know light travels in straight lines, but this seems a little different. Let's make sure we understand how light is focused to a point on the retina at the back of the eye.

In your notebook



8. Write the investigation question at the top of the next available page in your notebook: **How does light interact with a lens?**

Investigate How Light Interacts with a Lens

Because the lens of the magnifying glass is transparent and shaped like the lens of the human eye, we will use the magnifying glass to explore how a lens interacts with light so we have a better understanding of what happens to light that enters the human eye.

With your group



9. Use the following procedure, and be prepared to share what you observe with the class:
 - Adjust the flashlight so that the beam of light is focused (rather than spread out).
 - Hold the flashlight above a page in a group member's notebook and move it up and down until the entire beam of light falls on the page. Use your pencil to trace around the light on the page.
 - Keep the flashlight at the same height and hold the magnifying glass between the flashlight and the page.
 - Move the magnifying glass up and down.
 - Hold the magnifying glass about midway between the flashlight and the page and trace around the light.

Safety Precautions



Never look directly at sources of bright light, including a flashlight. Even relatively small amounts of laser light can lead to permanent eye injuries.

Building Understandings Discussion

With your class



10. Discuss this with the class:

- What happens when the magnifying glass is placed between the flashlight and the page?
- How does the magnifying glass and flashlight model compare to light entering the lens of the eye (the system we are modeling)?

Develop a Model

With your class



11. As you work with the class to make sense of what you observed, collaboratively develop a model on chart paper. The model should represent what happened when we shined the flashlight through the lens onto our notebook page.

Make Connections

Turn and talk



12. Discuss with your partner:
- What have we figured out about light transmitting through the lens of the eye?

With your class



13. Share your thinking with the class.
14. Add what we have learned to the Science Ideas chart.

Draw Tentative Conclusions

Now that we have a better understanding of what happens to light as it passes through the lens of the eye, we are ready to apply what we have learned to explain why Mr. Bean can see himself..

With a partner



15. Discuss this with your partner:
- What happens when light enters Mr. Bean's eyes so that he can see himself?
16. Use what you have learned from the video and your observations from the investigation to describe what happens when light enters Mr. Bean's eyes so that he can see himself.
17. Share your description with the class.

Revise the Class Model

With your class



18. Work with the class to revise the model created after watching the video:
- Change the color of the light input and the electrical signal to orange.
 - Add a key to the model to indicate that the orange color represents the light that reflects off Mr. Bean, into the one-way mirror, and into Mr. Bean's eyes.

Navigation

Turn and talk



19. Turn and talk to your partner about these questions:
- What have we figured out so far?
 - What are our next steps?

Set Up Our Science Notebooks

In your
notebook



20. Write the lesson question at the top of the next available page in your notebook:
 - Why does Mr. Bean not see the men?
21. Draw a 2-column Notice and Wonder chart.
22. Draw 2 lines across the chart to create 3 rows, and number the rows. You will use each row to document what you notice and wonder as you observe 3 different sets of images.

What do you notice? What do you wonder?

In your
notebook



23. Compare the images in each of the 3 sets. In your notebook, document what you notice and wonder for each set of images.

Image set #1

The same flashlight is shining in both images. The flashlight is turned on in a well-lit room and in a darkened room.



Image set #2

Both images show the same cellphone with the same message on the screen. One image shows the cellphone in bright sunlight, while the other shows the cellphone indoors.

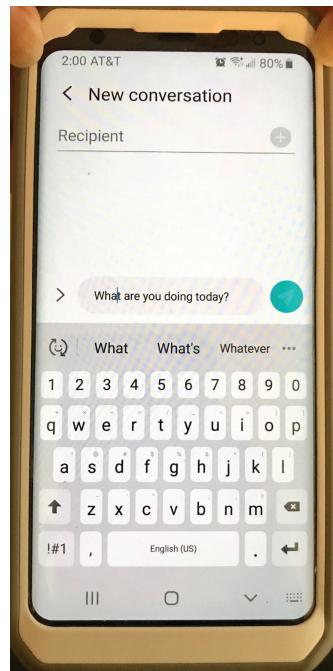
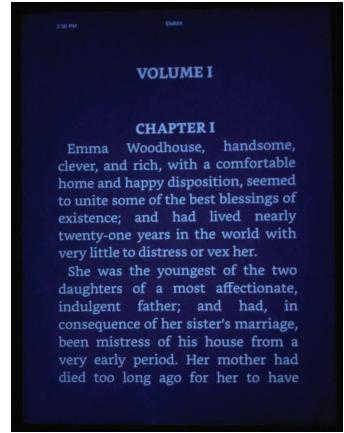
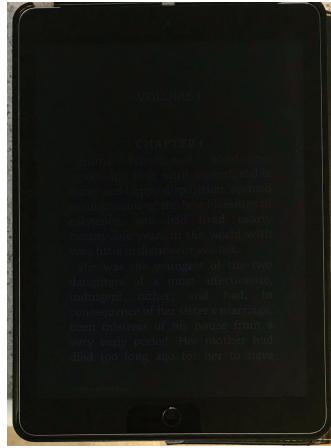


Image set #3

The tablet in both images is showing the same thing. One tablet is in a well-lit room and the other is in a dark room.



Debrief the Experience

With a partner



24. Share what you noticed and wondered with your partner.
25. Discuss the following questions:
 - When you look at each set of images, why do you think the object looks different in each image?
 - Have you had any experiences similar to these? Describe one to your partner.

Discuss How the Brain Processes Multiple Inputs

With your class



26. Discuss with the class:
 - What do all 3 sets of images have in common?
 - When our brain receives 2 sets of light input, such as bright sunlight and light from a cellphone screen, which light input does the brain pay attention to?

Develop a Group Model

With your group



27. Use our revised class model from the end of day 1 and work with your group to develop a model that explains why Mr. Bean sees himself but does not see the men.
28. Use these questions to guide your thinking:
 - How many inputs of light enter Mr. Bean's eyes?
 - Which light input is stronger and which is weaker?
 - Which light input is already represented in our revised class model from day 1?
29. Document your work on the notebook page opposite your model from Lesson 5.

Conduct a Consensus Discussion

Scientists Circle 30. Answer the following questions as you share your group model with the class:



- What does your model need to explain?
- What components did your group include in your model?
- How did you represent the 2 different light inputs into Mr. Bean's eyes?
- How did you represent the 2 signals that travel to the brain?
- How does Mr. Bean's brain respond to the different signals it receives?

Develop a Class Consensus Model

Scientists Circle 31. Work together to develop a class consensus model that explains why Mr. Bean sees himself but doesn't see the men. Document your work on chart paper.



32. Add the following idea to the Science Ideas chart:

- When multiple light inputs are detected by the sense receptors in our eyes, they are turned into signals. The brain responds to the strongest signal.

Navigation

We know 2 light inputs enter Mr. Bean's eyes--one input that has reflected off Mr. Bean, and one input that has reflected off the men. We also know Mr. Bean only sees himself.

On your own



33. Why does Mr. Bean not see the men?

Lesson 7: Why do Mr. Bean and the men see Mr. Bean but Mr. Bean doesn't see the men?

Navigation

With your class



1. Develop an explanation

- Why do the men see Mr. Bean?
- Why does Mr. Bean see himself but not the men?

Draft an Explanation as a Class

Why do the men see Mr. Bean?

On your own



2. What science ideas do we need to answer this question?

Review

- the models from Lessons 5 and 6
- the class Science Ideas chart
- your Progress Tracker

With your class



3. Draft an explanation to answer this question.

- The men see Mr. Bean because _____.
- Our evidence for this is _____.

Draft an Explanation Individually

Why does Mr. Bean see himself but not the men?

On your own



4. What new ideas from our models or Science Ideas chart do we need to answer this question?

Review

- the models from Lessons 5 and 6
- the class Science Ideas chart
- your Progress Tracker

In your notebook



5. Draft an explanation on *Explaining the one-way mirror phenomenon*.

Evaluate Your Explanation

In your notebook



6. Read *Self Assessment and Peer Feedback* and evaluate your explanation.
7. Consider how to revise your explanation. Record directly on your explanation your notes about what to revise.
 - Does the explanation include both why Mr. Bean sees himself AND why he does not see the men?
 - Does the explanation include important parts of the system and how they interact? Are there additional interactions to include?
 - What evidence from investigations does the explanation use? Is there additional evidence to include?

Evaluate a Peer Explanation

On your own



8. Read the “Peer feedback” column on *Self Assessment and Peer Feedback*, swap explanations with someone, and evaluate their explanation.
9. Provide feedback on how to revise their explanation.
 - Record notes directly on the explanation about what to revise. Your feedback should give ideas for specific changes or additions the person can make. Use sentence starters in *Peer Feedback Guidelines* if you need help writing feedback.

Revise Your Explanation

On your own



10. Review peer feedback.
 - Read the feedback carefully. Ask someone else to help you understand it, if necessary.
 - Decide if you agree or disagree with the feedback and reflect on why you agree or disagree.
 - Revise your work to address the feedback.
11. Based on your self-assessment and peer feedback, draft a revised explanation on *Final explanation: One-way mirror phenomenon* for question 2.
 - Why does Mr. Bean see himself but not the men?
 - Explain one piece of feedback you used and why.
 - Explain one piece of feedback you didn't use and why.

Navigation

With your class



12. We can explain the phenomenon!

Lesson 8: Why do we sometimes see different things when looking at the same object?

Navigation

The one-way mirror is a special material that is half-silvered, but the one-way mirror phenomenon does not work in every situation even when the material does not change.

With your class



1. Share your ideas with your class.

- What are the light conditions needed for the one-way mirror phenomenon to occur?
- How could we change the light to make the one-way mirror phenomenon stronger or weaker?

Investigation to Strengthen or Weaken the Phenomenon

With your group



2. Using the box model, investigate the best and worst light conditions for the one-way mirror phenomenon.
3. As you make observations, discuss these questions:
 - What light conditions led to the best one-way mirror phenomenon?
 - What light conditions led to the worst one-way mirror phenomenon?
 - What can you conclude about the relationship between light conditions and the phenomenon?

Share Observations and Conclusions

With your class



4. Discuss these questions:

- What did you observe about light conditions and the one-way mirror phenomenon?
- What can we conclude about light conditions based on our observations?
- How do the light conditions relate to the amount of light reflecting off objects and into our eyes?

Examine Related Phenomena

Turn and talk



5. Examine the Related Phenomena list and the Self-Documentation Collection with your partner.
6. Identify phenomena that may also be explained using the idea about light differences on both sides of a material.

**With your
class**



7. Share related phenomena with your class. When you share make sure to answer these questions:
- Where are the differences in light in this situation?
 - Where can people see their reflection? Why?
 - What allows people to be able to see through the material?

Describe Systems for New Phenomena

Turn and talk



8. Pick a new phenomenon. Think about the system in which the phenomenon occurs.
9. Discuss these questions:
- What are the important parts?
 - What are the interactions among those parts?
 - How would you decide the boundary of the “system” in which this new phenomenon occurs?

**With your
class**



10. Work with your class to co-construct a definition for *system* to add to your Word Wall.

Compare One-Way Mirrors and Glass Windows

**With your
class**



11. Discuss the following questions:
- What is similar or different about the one-way mirror and a glass window?
 - How can a glass window act like a one-way mirror even though it has a different structure?
 - What ways could you test your ideas using the box model?

Test a Different Material

**With your
group**



12. Work with your group to investigate the best conditions for glass to act like a one-way mirror using the box model.
13. Record in your science notebook the different conditions you test and what you observed.

Home Learning

Home learning



14. At your home, look out one window multiple times this afternoon, this evening, and tomorrow morning.
15. Make observations and take photographs (without flash) if you are able.
 - Can you see your reflection? How strong or weak is it?
 - Can you see through? How much can you see through?
 - What is the difference in light inside and outside?

Share Observations and Conclusions about Glass Windows

With your class



16. Use your observations of glass in the box model and your observations at home to draw conclusions about glass windows. Discuss the following questions:
 - What did you notice when you tested glass in the box model?
 - What did you notice when you observed a window at home at different times of day?
 - In what light conditions did the glass act most like a one-way mirror?
17. Explain a common, everyday experience at your school:
 - Why do we see different things when looking at this same classroom window?

Add New Science Ideas We Figured Out

With your class



18. What new science ideas help us explain why we see through and also see reflections in glass?

Portraits Through Glass

With your class



19. Examine a set of photos where glass causes a reflected image. Consider the following questions for each:
 - What is most prominent, or clearest, in the photograph?
 - What is less prominent, or hard to see, in the photograph?
 - What does the prominence of an object in the photograph tell you about the light that would be entering your eyes from it?

Portraits Through Glass Assessment



20. Complete the assessment on your own. Apply science ideas and evidence from classroom investigations to explain why you see what you see in this photograph.

Evaluate Our DQB Questions

With your group



21. Identify which questions on our DQB you think we've answered.

Symbols

- We did not answer this question or any parts of it yet: ?
- Our class answered some parts of this question, or I think I could answer some parts of this question: ✓
- Our class answered this question, or using the ideas we have developed, I could now answer this question: ✓ ✓

Revisit Our Driving Question Board

Scientists Circle



22. Work with your class to answer questions on the DQB. Think about these points:

- Which questions have we made the most progress on?
- What have we figured out related to those questions?

Quick Write: Reflect on Our Experiences

On your own



23. Answer the following questions in your science notebook.

- What was most challenging in this unit?
- What was most rewarding?
- *Think about how you engage in sensemaking discussions with classmates.* How would you want to engage in those experiences the next time around?
 - a. What would you do the same?
 - b. What would you do differently?



References



Peer Feedback Guidelines

Giving Feedback to Peers

This tool was inspired by the Sticky Note Feedback resource originally developed by Ambitious Science Teaching at: <https://ambitiousscienceteaching.org/sticky-note-student-feedback/>

Feedback needs to be specific and actionable

That means it needs to be related to science ideas and have your own suggestions for improvement.

Productive examples:

- "Your explanation said that the light reflects off the one-way mirror. I think you should add details about how much light reflects off the one-way mirror and why."
- "Your explanation said that the one-way mirror is half silvered. I think you should add details about what half silvered means and how light interacts with it."
- "Your explanation said that the light reflects and transmits off objects, but we've seen a lot of objects, like the people, that you can't see through at all. I disagree and suggest reviewing the reading about glass, the one-way mirror, and a regular mirror."

Unproductive examples of feedback that do not help other students improve are:

- "I like your explanation."
- "I agree with everything you said."

How to Give Feedback

Your feedback should give ideas for specific changes or additions the person or group can make. Use the sentence starters below if you need help writing feedback.

- I like how you _____. It would be more complete if you added _____.
- I see you're thinking about _____. Do you think you should add _____?
- The explanation said that _____. I disagree because _____. I think you should change _____.
- I agree that _____. I think you should add more evidence from the _____ investigation.
- I agree/ disagree with your explanation that _____. However, I do not think the _____ (evidence) you used matches your explanation.

Receiving Feedback from Peers

The purpose of feedback is to get ideas from your peers about things you might improve or change to make your work more clear, more accurate, or better supported by evidence you have collected. It can also help you to communicate your ideas more effectively to others.

When you receive feedback, you should take these steps:

- Read it carefully. Ask someone else to help you understand it, if necessary.
- Decide if you agree or disagree with the feedback and say why you agree or disagree.
- Revise your work to address the feedback.



Readings

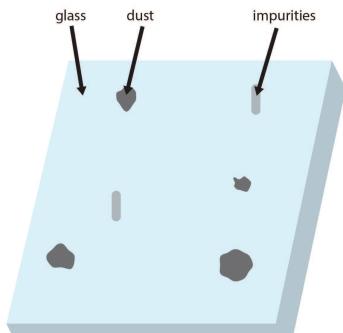


How is a one-way mirror made?

To understand how a one-way mirror is made, first we need to understand how a regular mirror is made.

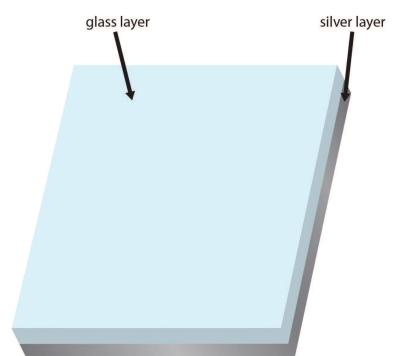
How is a regular mirror made?

Making a regular mirror starts with a piece of glass or plastic. A piece of glass is transparent because it transmits most of the light that shines on it. It cannot transmit all the light because there are impurities in the glass as well as dust and other things on its surface. Light reflects off the dust and impurities to our eyes, which is how we see the glass.



Glass with dust and impurities

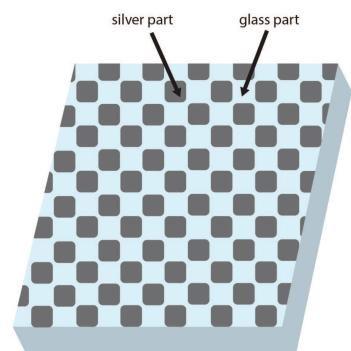
To make a mirror, a thick layer of smooth metal, such as silver, is added to the back of the glass. This process is called “silvering.” Behind the silver layer is a layer of paint to protect the back of the mirror. With the silver layer and paint layer, the mirror is opaque, meaning that no light can transmit through it. All the light reflects off it.



Mirror with thick silver layer

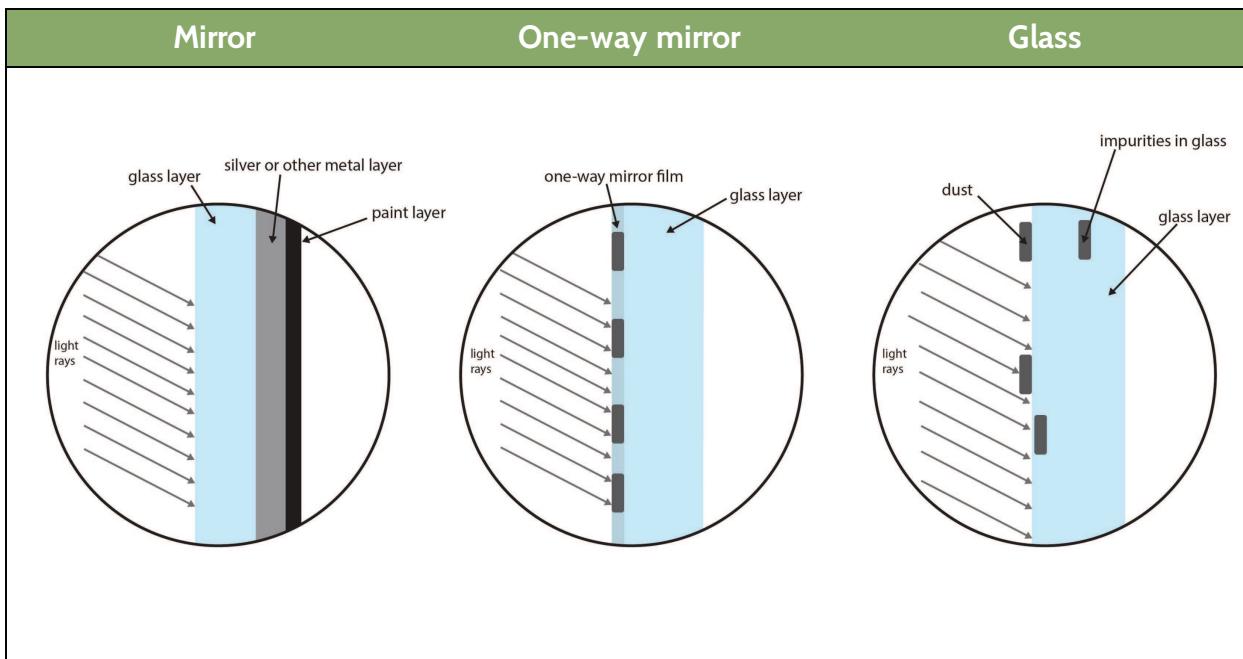
How is a one-way mirror made?

A one-way mirror is made by combining a thin layer of one-way mirror film and a piece of glass. The one-way mirror film has special structures that we can only see when we zoom into a scale we cannot see with our naked eyes. The one-way mirror film is made of a very thin layer of silver, aluminum, tin, or nickel that is mixed into a clear piece of plastic. This creates a “half-silvered” plastic film. The half-silvered film is added to the front side of a piece of glass. Because the silver layer is so thin, this leaves some parts of the glass fully transparent, while other parts are covered by silver. The result is a material that has some transparent surface and some reflective surface.



One-way mirror with thin silver layer

If 10 light rays shined on a mirror, a one-way mirror, and a pane of glass, what would happen to the 10 light rays? Draw your ideas on the diagrams below.



What new ideas do you have to answer the question, “How do similar amounts of light transmit through and reflect off the one-way mirror?”

How do eyeglasses help people see better?

Your eyes are not like anyone else's. The color can be one of a number of shades of color, but it is how well your eyes see and how they work that makes them really unique.

The eye is made up of a number of components or parts that work together, along with the brain, to process inputs of light into what we see every day. But sometimes our eyes don't work the way they should, and the world looks a little blurry. We may need help to see things far away, up close, or both. These common vision problems are easily fixed with eyeglasses or contact lenses. So how do glasses and contacts work? How do they help us see things clearly when our eyes can't do it alone?



You are unique!

Common Types of Vision Problems

The human eye is shaped like a ball or sphere.

Sometimes the eye is slightly longer or shorter than it should be, and sometimes it is unevenly shaped.

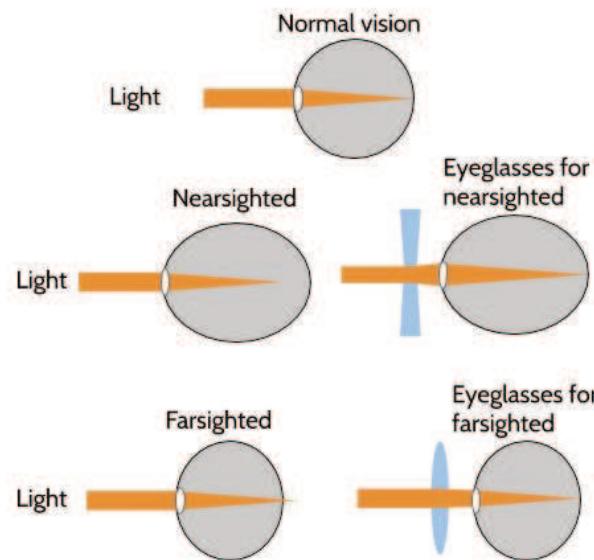
Being incorrectly shaped changes how well the eye focuses light on the retina at the back of the eye.

This causes vision problems.

If a person has eyes that are long from front to back, this causes them to be "nearsighted". Without glasses, they can see things up close. This means they can easily do things like read a book. But objects far away, like street signs, appear blurry.

Other people have eyes that are short from front to back. This shape causes them to be "farsighted".

Without glasses, they can see things far away, such as road signs and billboards. But they struggle to read things up close, like a computer or a newspaper. The text on objects up close appears blurry. In both cases, the lenses in glasses correct the vision problem because they allow the eye to focus light in the right spot on the retina.



Lenses correct nearsighted and farsighted vision

How Glasses Work

People of all ages wear glasses to help them see things more clearly. Even though there are different kinds of glasses for different vision needs, all glasses work in a similar way. The lenses in glasses help your eyes focus the light entering your eye at the exact spot that produces the clearest image. If you wear glasses, the shape of the lenses depends on the type of vision problem you have. The thickness of the lenses depends on how severe your vision problem is. Together, the proper shape and thickness will help your eyes focus light so you can see clearly.



Eyeglasses bring things into focus REDPIXELPL/Shutterstock

Lenses can be made of different materials. In the past, they were made of glass, but glass is very heavy, especially if you need thicker lenses! Today, most lenses are made of plastic, which is lighter than glass. Plastic can also be made into thinner lenses that do the same job as thicker glass lenses. Glasses are even considered to be very stylish, as they come in a wide variety of colors, shapes, and materials. Many people enjoy wearing glasses not only to see better, but also because glasses make them look better!

Walt Disney Concert Hall Case Study

The issue

In 2003, the Walt Disney Concert Hall in Los Angeles, CA, opened to the public. The concert hall is made from stainless steel with smooth curving walls. Soon after the concert hall opened, people from nearby neighborhoods started to complain about the glare from the building. Drivers also reported that they were being blinded by light reflecting off the building.

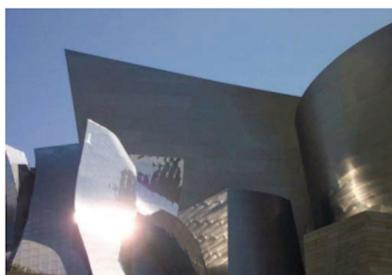


Giuseppe Milo. CC BY 3.0

The solution

The architects identified that the parts of the building causing the glare were coated in polished steel. The rest of the building used brushed steel. To fix the problem, they considered multiple options. The best option was to sandblast the surface of the polished steel to make it rough. Before sanding, the workers could see their reflections when they looked at the polished steel. After sanding, the building looked dull gray, like the non-shiny side of aluminum foil. The sandblasting solved the problem, and the Walt Disney Concert Hall received no more complaints.

Images of the building before sanding

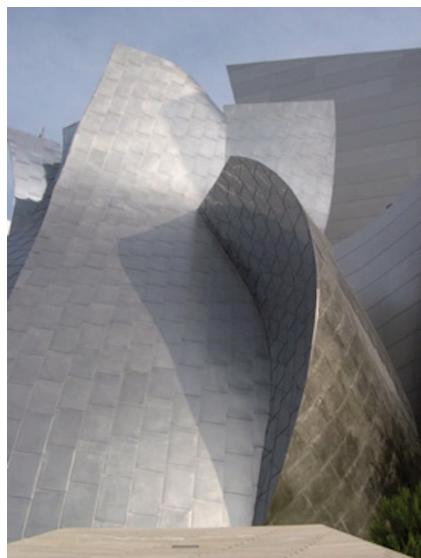


Microclimatic Impact: Glare around the Walt Disney Concert Hall, by Marc Schiler and Elizabeth Valmont. Used with permission.



Microclimatic Impact: Glare around the Walt Disney Concert Hall, by Marc Schiler and Elizabeth Valmont. Used with permission.

Image of the building after sanding

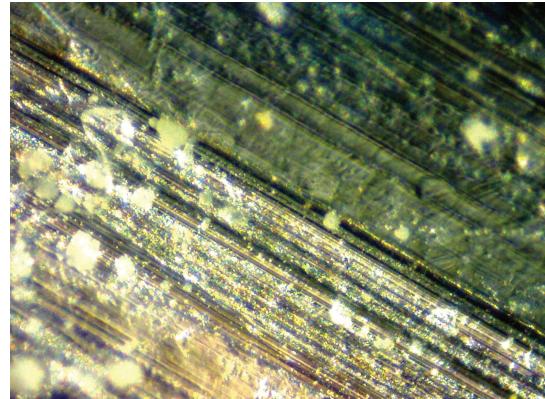


John O'Neill

Why did sanding the surface of the building reduce the glare?

We need to zoom in to a microscopic scale to answer this question. While we can see some differences with our eyes, looking under a microscope reveals new structures. For example, when we look closer at aluminum foil under a microscope, the surface is not completely smooth.

Before sanding, the surface of the building's polished stainless steel was very smooth under a microscope. After sanding, the surface still looks smooth to our eyes, but under a microscope, the surface is rough.



Aluminum foil under microscope Achim Hering. CC BY 3.0

When light shines on any surface, it always reflects off the surface in a V shape. If the surface of an object is very smooth at the microscopic scale, all the light reflects in the same direction. This is why you see a glare when light shines on really polished materials. If the surface is rough, light reflects in all different directions. This type of reflection is called *scattering*. Many objects that appear smooth to our eyes actually have rough surfaces when examined under a microscope. This is why you do not see a glare coming off most unpolished objects even though light reflects off them to your eyes.

