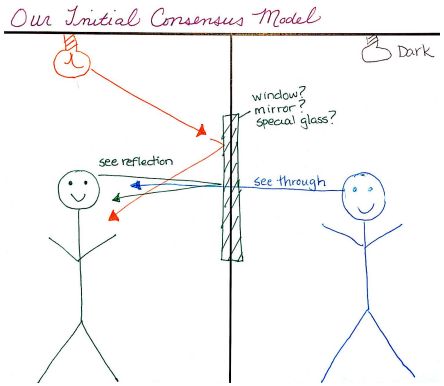
UNIT STORYLINE

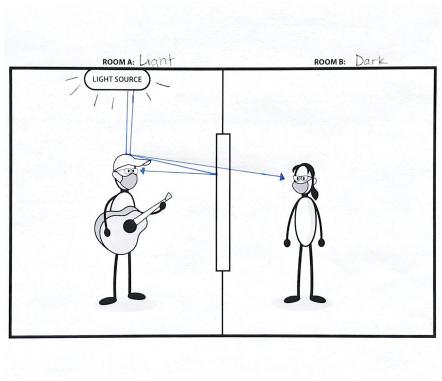
How students will engage with each of the phenomena

HANDS-ON/ LAB ACTIVITIES | VIDEOS OR IMAGES | DATA SETS | READINGS | COMPUTER INTERACTIVES

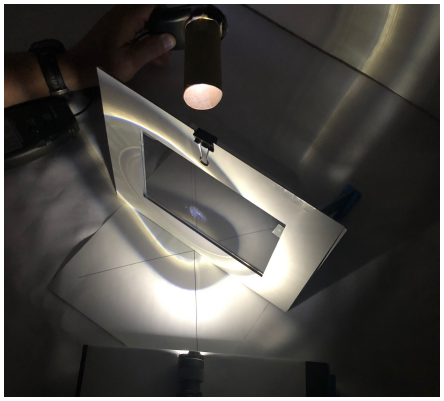
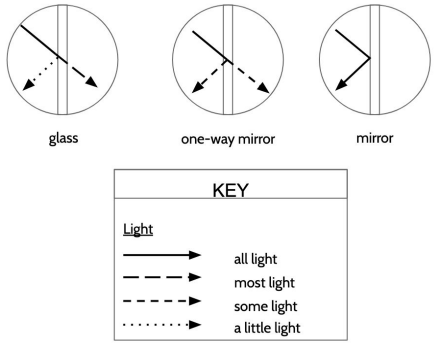
Unit Question: Why do we sometimes see different things when looking at the same object?

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 1 4 days **How can something act like a mirror and a window at the same time?** Anchoring Phenomenon	 *A piece of material looks like a mirror from one side and a window from the other side.*	We watch a puzzling video of a music student who can see his reflection in what seems to be a mirror. The student doesn't see the teacher on the other side of the mirror, but the teacher can see through it like a window. We wonder how something can act like a mirror and window at the same time. We investigate the system using a box model that represents it. We develop an Initial Class Consensus Model, brainstorm related phenomena, and develop a Driving Question Board and an Ideas for Investigation chart. We figure out these things: • Some materials can be reflective and see-through at the same time. • Whether the material is reflective or see-through may be related to where there is a light.	

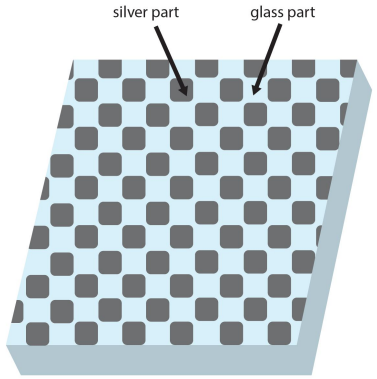
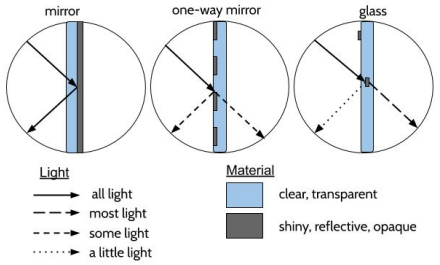
⇓ **Navigation to Next Lesson:** We figure out that the light on the other side of the mirror-window is likely important to whether it acts like a mirror or a window. We make predictions about how switching the light from Room A to Room B will affect what is seen.

LESSON 2 3 days **What happens if we change the light?** Investigation	 *The one-way mirror phenomenon happens when there is a difference in light between the two sides of the material.*	In this lesson, we observe the one-way mirror in and out of the box model. We move the flashlight to Room B, make both rooms light, and make both rooms dark. We figure out these things: • When we change the location of light in the box system, the phenomenon reverses. • Reflection happens on the side that is lit, while the side that is dark is see-through. • The one-way mirror phenomenon is strongest when there is a difference in light between the rooms. • Light travels in straight lines. • For us to see an object, light must leave a light source, bounce off the object, and travel in a direct path to enter our eyes.	

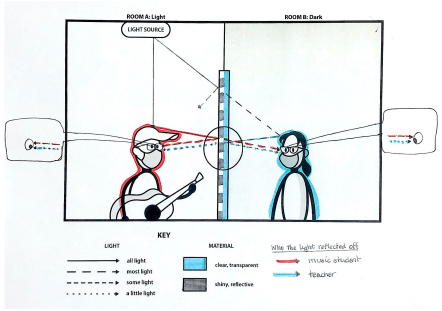
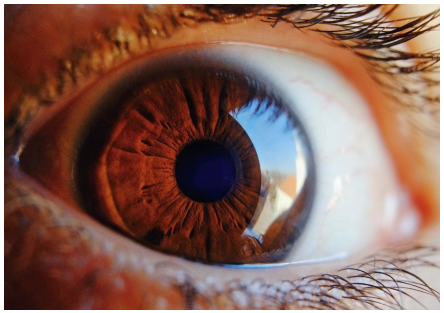
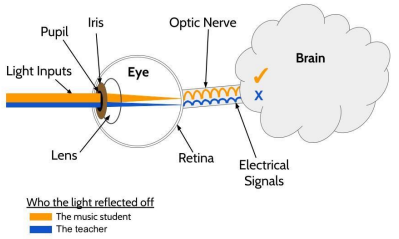
⇓ **Navigation to Next Lesson:** We figure out that the difference in light between the rooms is causing us to see different things from either side of the one-way mirror in the box model. We wonder how the phenomenon would change if the one-way mirror material was regular glass or a regular mirror.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 3 3 days **What happens when light shines on the one-way mirror?** Investigation	 *Different materials reflect and transmit different amounts of light, as measured quantitatively by a light meter.*	We know that the one-way mirror acts like a mirror in a brightly lit room and acts like a window in a dark room. To figure out why it behaves this way, we compare what happens when light shines on the one-way mirror, a pane of glass, and a regular mirror. We record initial observations and then use a light meter to measure the amount of light transmitted through and reflected off each of those materials. We use a tool to develop an experimental question and then plan the investigation. We document our observations and analyze data to figure out what happens when light shines on the one-way mirror. We figure out these things: • Light travels in straight lines. (reinforcing 4th grade) • When light shines on an object, it is reflected (bounces off), transmitted (passes through), or some combination of these, depending on the object's material.	

⇓ **Navigation to Next Lesson:** We think the one-way mirror acts like a regular mirror because the two materials have something in common. But, we know they are not exactly the same, since the one-way mirror lets some light transmit and the mirror doesn't. Our next step is to try to figure out what the one-way mirror and the regular mirror have in common.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 4 1 day **How do similar amounts of light transmit through and reflect off the one-way mirror?** Investigation	 *A one-way mirror has a thin silver layer compared to a regular mirror that is fully silvered and glass that is not silvered.*	We wonder how similar amounts of light transmit through and reflect off the one-way mirror. We think it has something to do with how the one-way mirror is made. We read more about regular mirrors and one-way mirrors and find out that regular mirrors have a thick layer of silver on the glass, and one-way mirrors have a thin layer of silver embedded in a plastic film on the glass. We modify a model to explain what happens when light shines on the different structures in each material. We figure out these things: • A material can have different structures, even at a microscale, that cause different amounts of light to transmit through or reflect off of it.	

⇓ **Navigation to Next Lesson:** In this lesson, we figured out that the one-way mirror is structured to transmit and reflect about the same amount of light due to half-silvering. We are ready to explain how the structure of the one-way mirror interacts with light to cause the one-way mirror phenomenon.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 5 1 day **How do light and the one-way mirror interact to cause the one-way mirror phenomenon?** Putting Pieces Together, Problematizing	 *The one-way mirror acts as a mirror on the lit side and as a window on the dark side.*	In this lesson, we revisit the anchoring phenomenon and model interactions between light, the people, and the one-way mirror to explain why the music student and the teacher all see the music student. We realize that a little light reflects off the teacher and enters the student's eyes, which makes us wonder why the student doesn't see the teacher. We figure out these things: • When light reflects off the music student and travels to the one-way mirror, about half of the light reflects off the silver structures back to the student's eyes and the other half transmits through the transparent parts to the teacher's eyes. • The light that transmits through the one-way mirror reflects off the teacher and travels to the one-way mirror. About half of that light reflects off the silver structures back to the teacher's eyes and the other half transmits through the transparent parts to the student's eyes.	
⇓ **Navigation to Next Lesson:** We figure out that there are two light inputs into the student's eyes: light that has reflected off the student and light that has reflected off the teacher. We wonder why the student doesn't see the teacher, and we share initial ideas.			
LESSON 6 2 days **Why does the music student not see the teacher?** Investigation	 *What we see is determined by the interactions between the light that enters the eye, the structures that make up the eye, and the brain, which processes the signals it receives from the eye through the optic nerve.*	In this lesson, we know that light has reflected off the teacher and enters the student's eyes. We wonder why the student can't see her. To figure this out, we obtain more information about what happens when light enters the eye. We model how light inputs transform into signals that the brain processes to tell us what we see. We think about experiences from our everyday lives to help us explain why we only see some inputs of light better than other inputs. We figure out: • Light changes direction (refracts) when it travels between different transparent materials. • When a light input is detected by sense receptors in our eye, it is turned into a signal that travels along the optic nerve to the brain, which processes it into what we see. • When there are multiple inputs, the brain responds to the strongest signal.	
⇓ **Navigation to Next Lesson:** Now that we know how the eye and brain make sense of light inputs, we are ready to develop an explanation for the one-way mirror phenomenon.			

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it

LESSON 7

1 day

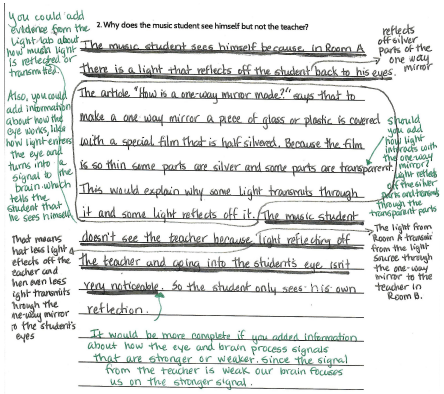
Why do the music student and the teacher see the music student but the music student can't see the teacher?

Putting Pieces Together

The music student can see his reflection in the mirror on the lit side but cannot see the teacher. The teacher on the dark side can see the music student through the glass.

We review the class models from Lessons 5 and 6, the class science ideas list, and our individual Progress Trackers. We develop a written explanation to answer the question: Why does the teacher see the music student? We individually draft an explanation to answer the question: Why does the music student see himself but not the teacher? We self-assess our explanations and give and receive peer feedback on them. We then revise a final explanation. We figure out:

- The music student sees himself because light reflects off the music student to the one-way mirror and reflects back to his eyes. This light input is the strongest signal that is processed by his brain.
- The teacher sees the music student because light reflects off the music student to the one-way mirror and transmits through the one-way mirror to her eyes. This light input is the strongest signal that is processed by her brain.
- The music student can't see the teacher and the teacher can't see her reflection because the light inputs from those objects are weaker and the brain doesn't respond to them.



⇓ **Navigation to Next Lesson:** We developed an explanation for the anchoring phenomenon and celebrated our accomplishments. In the next lesson, we will apply our model to related phenomena to see what else we can explain.

LESSON 8

3 days

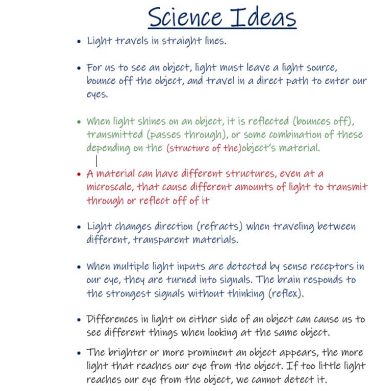
Why do we sometimes see different things when looking at the same object?

Investigation, Putting Pieces Together

Materials like glass can act like one-way mirrors when there is a differential in light on both sides of the glass.

We investigate the best light conditions for the one-way mirror phenomenon to occur and decide the effect is greatest when there is a large difference in light on both sides of the material. We use this idea to investigate related phenomena. We conclude that other materials, like glass, can act like one-way mirrors in situations in which there is a similar light differential on either side of the material. We use our model and science ideas to demonstrate what we have learned on an assessment. We revisit the DQB to document the questions we have answered in the unit and to reflect on our learning. We figure out these ideas:

- Differences in light on either side of an object or material can cause us to see different things when looking at the same object or material.
- The brighter or more prominent an object appears, the more light that reaches our eyes from the object.



LESSONS 1-8

18 days total