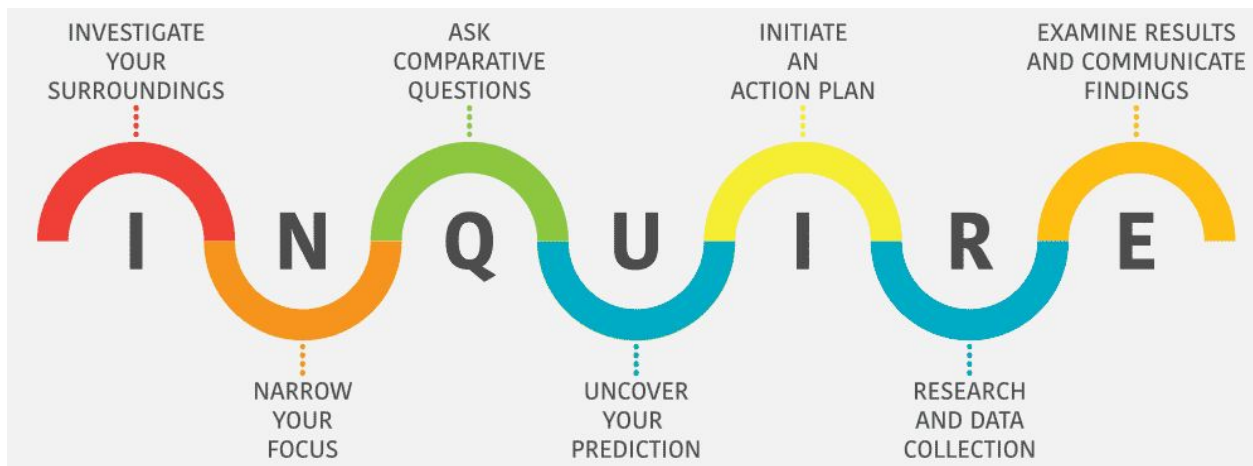


Simple Shadows

An inquiry-based lesson plan designed to promote critical thinking by integrating content with traditional and inquiry-based learning.



All Hands-On Learning is NOT Inquiry-Based Learning

Inquiry based learning is process-oriented and does not focus on a single correct answer, but rather emphasizes the process of gathering information and forming a conclusion. Traditional hands-on learning tends to be product-oriented and has students follow a pre-planned procedure to come to a single, specified answer.

Key Terms

Process Skills (PS)

Skills that students will engage in while thinking critically. These include observing, questioning, predicting, planning, investigating, interpreting, and communicating. These skills are found in each step of the inquiry process.

Investigating Surroundings

Observing the overall surroundings. What do I see? What is understood about the topic? What still needs to be understood?

Narrowing Focus

Observing student needs and interests, as well as academic content. Find the balance between natural curiosity and standards-based concepts. What area can be concentrated on to best promote growth and learning?

Questioning

Forming questions about what is not fully understood. Comparative questions can be investigated. They need to be able to lead into an action plan. What can be found out?

Uncover Prediction

Logically thinking to form a prediction about what could happen. What do I expect to happen based on my experiences and knowledge?

Initiate Plan

Figure out the action plan. Design an experiment which will answer the comparative question. What can I do to answer this question? How can I find this out?

Research and Collect Data

Investigating the elements of the experiment. Researching and collecting data that applies to the action plan.

Examine Results

Interpreting the data collected. What does this data mean? What else do I want to find out?

Communicating

Communicating the information that was found to someone else. The way the data is presented. What will the audience want to know? What will the audience be able to understand about this?

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Overview

This is an inquiry-based learning lesson in which students learn about light and shadows. Students will be engaged in hands-on activities that involve investigating light and the way shadows are made. They will analyze their findings and present to the class. The project will link IBL with traditional teaching by giving teachers options to best suit the needs of the class. More questions will emerge to continue scientific investigations and further the learning process.

Practical Application

This experiment allows students to understand how shadows are formed and how light affects them. Each student will have practice with the scientific process, including documenting and interpreting data.

Lesson Plan

Grade Level: Pre-K

Class:

Teacher:

Time Required/Duration: 2 days, 30 minutes each day

Objectives

1. Incorporate the process of inquiry-based learning into a traditional direct instruction classroom setting.
1. Students will be able to use multiple means to find answers to their questions, including but not limited to participating in the inquiry experience, reading information from primary and secondary sources, watching videos, and talking with more knowledgeable individuals in their community.
2. Students will be able to identify that a shadow is made by blocking light from touching the surface.
3. Students will be able to design an experiment to answer a comparative question.
4. Students will be able to complete steps in investigating shadows.
5. Students will be able to uncover additional questions and think critically about the data found.

Educational Standards

Physical Science. Explorations of Energy: With modeling and support, explore the properties and characteristics of sound and light.

Materials

Needed:

1. Construction paper
2. Scissors
3. Blocks (Any kind can be used, but large, connecting blocks work best)

~~IBI Institute Provided at No Charge (Shipping and handling fees will apply):~~

1. Flashlights for each group
2. One meat thermometer

~~To order the IBI Institute provided supplies, please contact Jessica Begonia at 419-223-1362 with how many students and groups you will have in your classroom. Supplies will be scheduled for delivery two days before the experiment starts.~~

~~Vocabulary~~

(See appendix 3 for Vocabulary defined)

Comparative Question	Sunlight
Prediction	Shadow
Observe	Thermometer
Action Plan	Temperature
Communicate Findings	

Instructional Plan

Day One

1. Introduce the concept of shadows.
2. Have students share their knowledge of shadows, write their ideas on the board. **(Investigate Surroundings)**
3. Explain that shadows are where the light does not reach the ground. Remind them of how when a movie is projected the light from the projector is blocked by their shadows when they walk in front of it, or any other example they can relate to their own experience.
4. Turn the lights off and set up the flashlight pointing at a blank area on the wall or white board. Demonstrate how to make a shadow butterfly with your hands. Show the students the shadow, asking why they think it is the shape that it is. (Directions for making this are in the section titled “Background Science- Teacher information, on page 10)
5. Ask what they think will happen when you move your hands, calling on a few students to answer. **(Investigate Surroundings)**
6. Talk about what happens to the shadows when the light moves.
7. Split the class into 2 small groups, then explain and demonstrate each station to the class.
8. Students will complete each station, spending 15 minutes on each one. The lights should be off during this time to allow students to see the shadows best. Lights can be turned on while switching stations. See page 8 for detailed instructions, and page 14 for group procedures.
9. Students will draw a picture of shadows using their learning from this lesson.
10. Students will be paired with a partner from another group to explain what they did and share the information from their investigation notebook. **(Examine Results and Communicate Findings)**

Day Two

1. Re-engage students in the concept of shadows.
2. Talk to students about where they see shadows in nature. (Clouds, trees, bushes, etc.)
3. Ask students how the shadows change the areas around them. Direct the discussion to the fact that without the light from the sun the areas cannot get as warm. **(Investigate Surroundings)**
4. Ask the students if they think the temperature of the ground covered in a shadow will be warmer or colder than the ground that sunlight is touching. **(Make a Prediction)**
5. Take a walk outside with the class, finding a shadow that has probably been there for a while. Use the meat thermometer to check the temperature of the ground in both the shaded and non-shaded areas.
6. Compare the two temperatures with the class. **(Analyze results)**
7. Do this for multiple shadows, until the class can come to a conclusion about the temperature change with shadows.
8. While finding different shadows, point out the differences that the placement of the light makes on the shadow made.
9. The teacher will administer the student feedback form.

Instructional Plan Continued

Day 1 Stations

1. Exploring Shadows Using Paper Cut-Outs (Requires Teacher Assistance)
 - a. Students will explore the different shape pictures. Guide them to think about what kind of shadow each of them would make, and how they would be different. **(Investigate Surroundings)**
 - b. Students will come up with a comparative question regarding the shadow and the paper cut outs (Ex. Will the shadow of the paper cut out close to the flashlight be bigger than the shadow of the paper cut out far away from the flashlight? Will a circle cover more space on the wall than a star?). Depending on the amount of experience students have with inquiry, they might be able to come up with these questions or they may need support. See “About Inquiry Based Learning as it Applies to this Lesson”, for more information on this. **(Ask Comparative Questions)**
 - c. Students will brainstorm and share how to find an answer to their question. **(Initiate Action Plan)**
 - d. Students will use the flashlight and the pre-cut shapes to investigate their comparative questions.
 - e. Students will record their findings in their Investigation Books. **(Research and Collect Data)**
2. Using Blocks to Create Shadows
 - a. Show the students the pictures of shadows of different block formations (Appendix 2, pages 20-22) .
 - b. Have them choose one shadow to try and recreate.
 - c. Ask students to come up with an action plan for how to position the blocks to recreate the shadow. There may be more than one way to get the same result.
 - d. Students will use the classroom blocks to recreate the shadow. **(Initiate Action Plan)**
 - e. Once they have finished making the structure, they will compare the picture of the shadow to their own shadow. Do they match? If not, how can it be changed to make them match?
(Research and collect Data)
 - f. If time allows, students can attempt to recreate a second shadow.

Instructional Overview

Day One

1. The teacher will introduce the topic of shadows.
2. The class will have a discussion about shadows and make a list of what they know.
3. The teacher will explain what shadows actually are and how they are made.
4. The teacher will demonstrate a shadow by making a shadow puppet.
5. The students will complete two stations to investigate shadows.
6. Students will draw a picture of shadows.
7. Students will talk with a partner what they learned about shadows in this lesson.

Day Two

1. The teacher will re-engage students by discussing where they see shadows in nature.
2. The class will talk about how shadows affect the area they cover.
3. The class will take a walk outside, taking the temperature of the ground in places covered by shadows and in the sunlight.
4. The students and the teacher will compare the temperatures.
5. The teacher will administer the students feedback form.

Post-Assessment

1. Each student will draw a picture of shadows to demonstrate their understanding of the concept.
2. Students will be paired to communicate their learning to a peer from another group.

Background Science- Teacher Information

Directions for making a butterfly hand shadow

1. Make this hand shadow puppet by holding both hands in front of you, palms facing your body. Your fingers should all be touching.
2. Cross one hand over the other, so that your thumbs are touching one another.
3. Move your fingers to make the shadow butterfly appear to be flapping its wings.

Shadows cover Earth's ground, prohibiting light from touching it. Since the light cannot touch, that means that the Earth is a little less warm than it would be without those shadows. Each one does not have too big of an impact, but these build up, creating a change in the climate. The exhaust from airplanes, the white cloudy trails that can be seen behind the planes, adds to this. These are known as contrails (which stands for condensation trails), more commonly known as Chemtrails. Though they are primarily composed of water vapor just like clouds, other chemicals have known to be released with the plane exhaust as well (Link provided below). These cause more shadows, adding to the lack of light/heat touching Earth's surface. Because plants, like the ones planted as crops for us to eat, need sunlight to grow, the more clouds there are the less likely they are to grow their best. In places where not many plants or trees can grow, like a desert, clouds may provide needed shade. Humans can create shade by making shadows with shelters they build.

https://www.faa.gov/regulations_policies/policy_guidance/envir_policy/media/contrails.pdf

NASA has an article about shadows at the link provided below. This can be read to the students, or sent home as supplemental material for parents to read to the students.

https://www.nasa.gov/audience/forstudents/k-4/stories/F_Keeping_Cool_With_Shadows.html

Journaling

Students will document their thoughts and questions each day for the duration of this lesson. Students will be writing or drawing in their investigation books, which they will add on to each day. If needing to keep track of what was written each day, students can use different colors to write with on different days throughout the lesson, or the teacher can print one sheet from the investigation book each day. Though this age will be mostly drawing pictures, anytime they want to include words with teacher assistance they should be encouraged to do so. Writing or drawing should be done each day, that way students can document what they have learned each day and add any new questions that come to their minds. If the students already regularly engage in a journaling activity, the teacher can choose to use that method instead of the investigation book. The goal of journaling is for students to reflect on their knowledge and how it has grown, as well as to think about and record the questions they have about this topic.

About Inquiry-Based Learning As It Applies To This Lesson Plan

This is a project that works best when students work in small groups (3-5 students). Inquiry is collaborative in nature. The process takes advantage of students' strengths to contribute to the project. Some are great communicators, some are problem-solvers, and some have well-developed technical skills. In the workplace, we also work in groups. We work as part of a team. The inquiry process develops skills necessary to solve complex problems in the world.

The students will benefit from the background science from the book plants and living things. Make sure the section on the background science is available to each group. Some in the group may have little interest in the material provided whereas others will want to read it in depth, but the end result will be that everyone in the group will know more about plants and what they need. Connect the relevance of the group working with plants as it relates to the comparative question.

Investigate your surroundings and narrow your focus: Encourage each group to think about shadows they have seen. This is a good time for students to ask questions. We suggest having them write individual questions on individual pieces of paper so the questions can later be sorted. It's not important to sort those now, but this can be revisited once the students are more in tune with the inquiry process.

Ask comparative questions: At the heart of inquiry is the comparative question. Comparative questions are ones that can be investigated. Some questions are very good questions, but they are very difficult to investigate. For example: Why are butterflies attracted to my flower garden? Good question, but difficult to investigate. However, we can take that question and change it to: Are butterflies attracted more to red flowers or white flowers? Do you see where we are going with this? You can now design an experiment to count how many butterflies visited each of the colors and compare the results. More questions will come of this process. Do the findings hold up for different kinds of butterflies? Another experiment can be designed. In the case of shadows, the comparative question, at least somewhat, is being provided by you. This makes the lesson plan a more guided inquiry, but is still left open for students to create their comparative question themselves. An open inquiry is one in which the students pick the topic, create the questions, create the action plan, etc. The comparative question for this lesson plan will be regarding shadows. Examples are: "Will the shadow be bigger if it is closer to the flashlight or further away?" "Will the shadow be a different shape with the flashlight close and far away?" Later, we will revisit the questions the students asked above and have them separate those questions that can be investigated and those that cannot. Often, questions that would be difficult to investigate can be made investigable by turning them into comparative questions

Uncover your prediction: We are not talking about group-think here. What do you individually think? Each group will be predicting what each shadow will look like. Each student will have a prediction and they should record that prediction. A prediction is not the same thing as a hypothesis. A hypothesis might be: All swans are white. A prediction would be: I think the next swan I see will be white. A prediction is based upon the individual's experiences, observations, opinions, knowledge, and instincts.

Initiate an action plan: The students will come up with an action plan for how to make a recreation of a shadow. Different students might have different ideas to go about doing this, and some may end up with the same results even with different processes. Have students explore as many of these processes as time allows. Letting them come up with this part is important, though it may be difficult to let them figure it out for themselves. When students need help, try to assist them by asking guiding questions so that they figure it out, instead of just telling them. Part of inquiry requires you to give up some control to allow your students to figure it out.

Examine results and communicate findings: Each group will present their findings to a peer. At this level, students are focused on understanding their investigation and its outcome. Having them recall the processes they went through and what those mean to someone they feel comfortable talking to can help them solidify their knowledge, as well as help them practice communicating information to one another. In the future, each group will be preparing a graphs, data tables, charts, and pictures to present to the class. They share their individual predictions. They share their analysis of the measurements and how their plant faired. How do they answer the comparative question? What did they learn from the experience? Classmates then have an opportunity to ask questions to the presenting group.

Student/Teacher Roles for Each Step:

Investigate your surroundings:	The students and the teacher are doing this
Narrow your focus:	The students and the teacher is doing this
Ask comparative question:	The students and the teacher are doing this
Uncover your prediction:	Each student is doing this
Initiate an action plan:	The students are doing this
Research and data collection:	The students and teacher are doing this*
Examine results and communicate findings:	The students are doing this

*You may use the data sheet provided or the student may create their own

Group Procedures

Station 1

1. Have shape cut-outs prepared for students to use.
2. Tell students to think about what types of shadows each shape would make. Ask them how they would be different from each other
3. Ask students to come up with a comparative question regarding the shapes and their shadows. Guide students into forming a question which compares two things and the shadows they create.
4. After the group has their question, they should brainstorm a way to find an answer to their question using the shapes and the flashlight.
5. They will investigate the shadows and record them by drawing pictures in their Investigation Books.

Station 2

1. Have the pictures of the block shadows prepared by setting them out in the block area for students, with blocks intended for them to use set out.
2. Tell students to talk about each shadow, and choose one as a group to try to recreate.
3. Have students plan a way to recreate it, such as what size blocks they will need and where they should be placed.
4. Allow students time to recreate the shadow by building a structure with the blocks.
5. Have students compare the shadow from the picture with the shadow their structure made. If they look different, ask the students what they can change to make them match better.

Extensions

1. Observe changes in shadows.
 - a. At the beginning of the day have students decide on an object outside that has a shadow that they would like to observe throughout the day.
 - b. Once students have decided on an object have them trace the object with sidewalk chalk.
 - c. At recess have students retrace their object with a different color of chalk. Discuss changes in the shadows of various objects.
 - d. Before the end of the day, trace the object a third time and discuss how the shadows changed throughout the day.
2. Take a walk outside with the class.
 - a. Have students look out for and observe the shadows around the school or playground.
 - b. Tell them if they find a shadow they think is interesting, to get the teachers attention, so that the class can stop to look at and discuss the shadow and how it was made.
 - c. Go inside and have students draw a picture from their walk, including one shadow.
3. Dance with shadows.
 - a. Play music, turn off the lights, point the flashlights at a blank wall.
 - b. Have students dance in front of the lights so that their shadows are visible.
4. Explore shadows that toys make
 - a. Use the classroom toys to explore what kind of shadows they make. By moving the flashlight in different angles, the shadows will appear to be shaped differently.



**Comparative Questions-
questions we can
investigate**



**Prediction- what you
think before you
investigate**



**Observe- to watch
carefully and notice
important details**



Action Plan- the steps you will take during your investigation



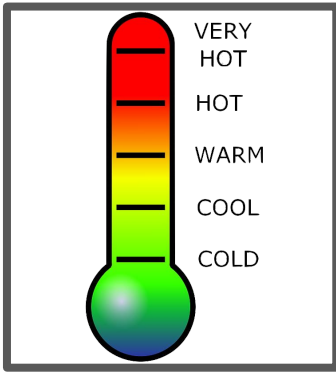
Communicate Findings- explaining what you found to your peers



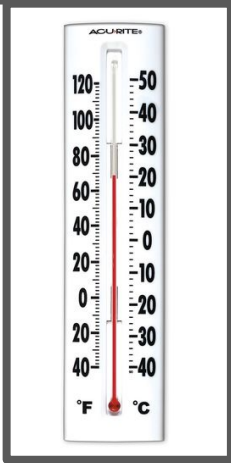
Sunlight- the energy that comes from the sun that creates some shadows



Shadow- dark area where light does not reach the surface



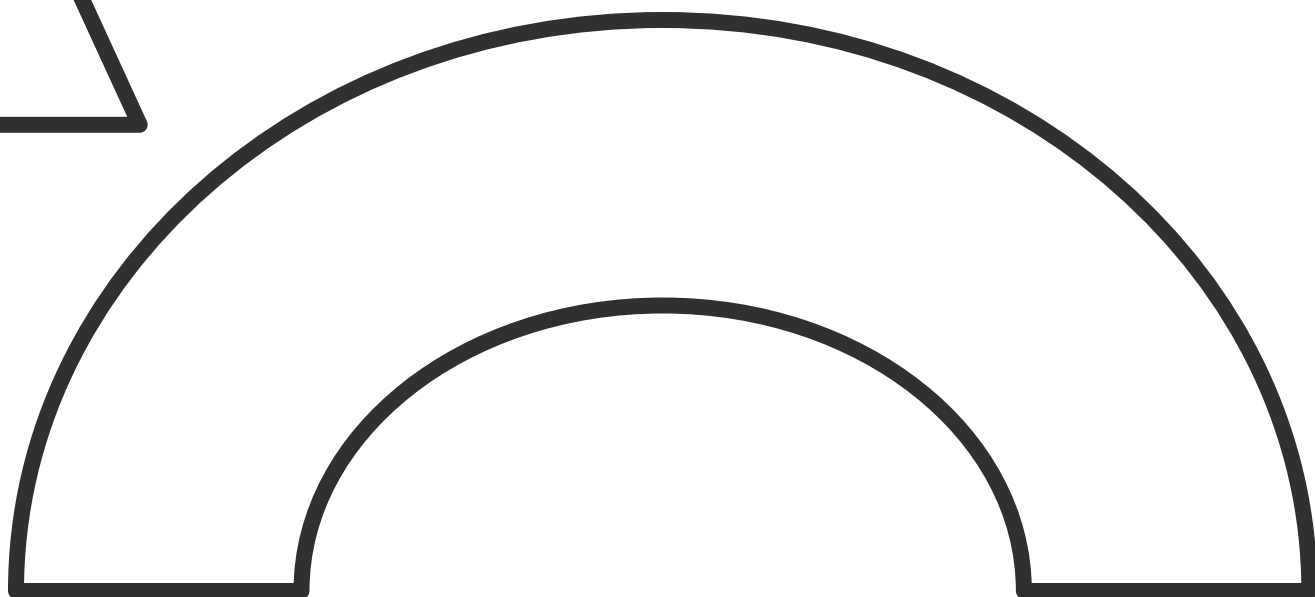
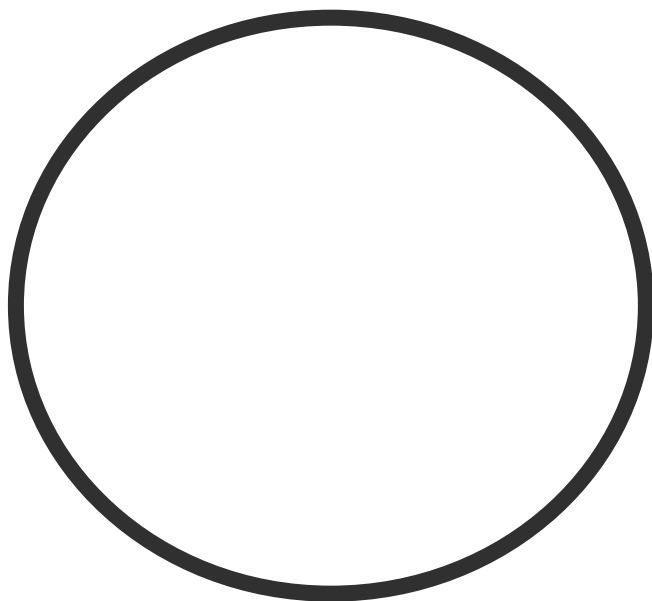
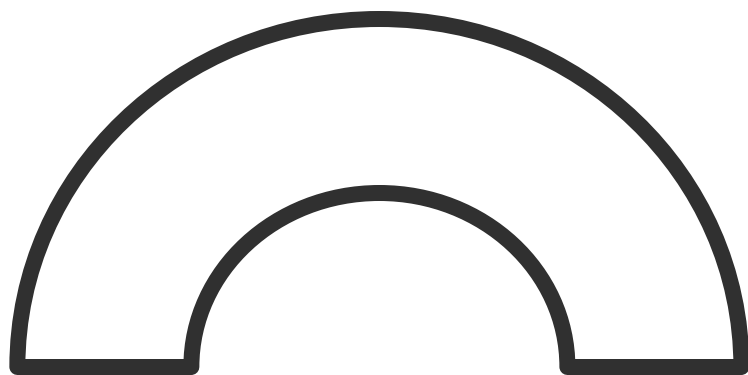
**Temperature-
measurement of how hot
or cold something is**

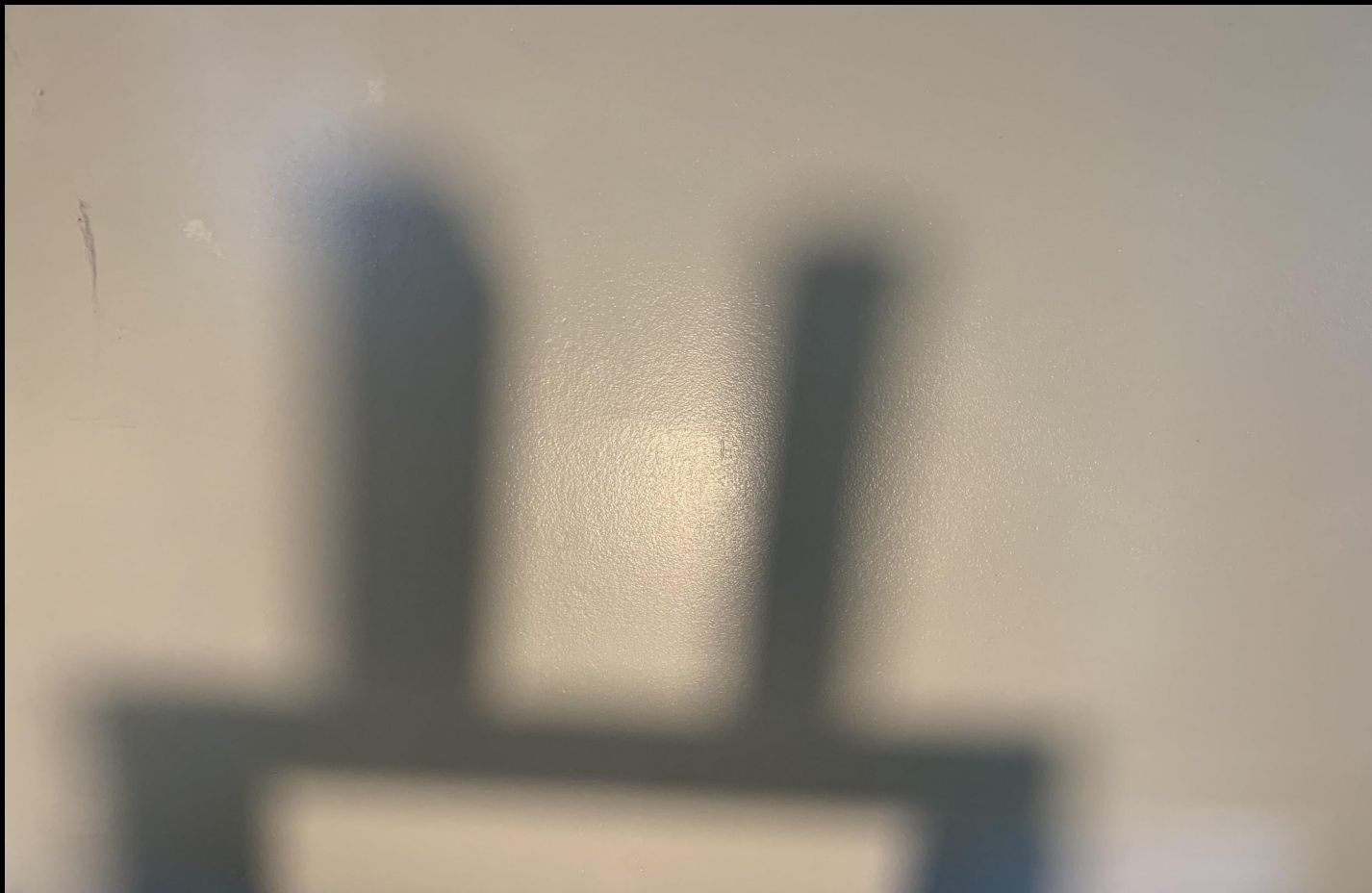
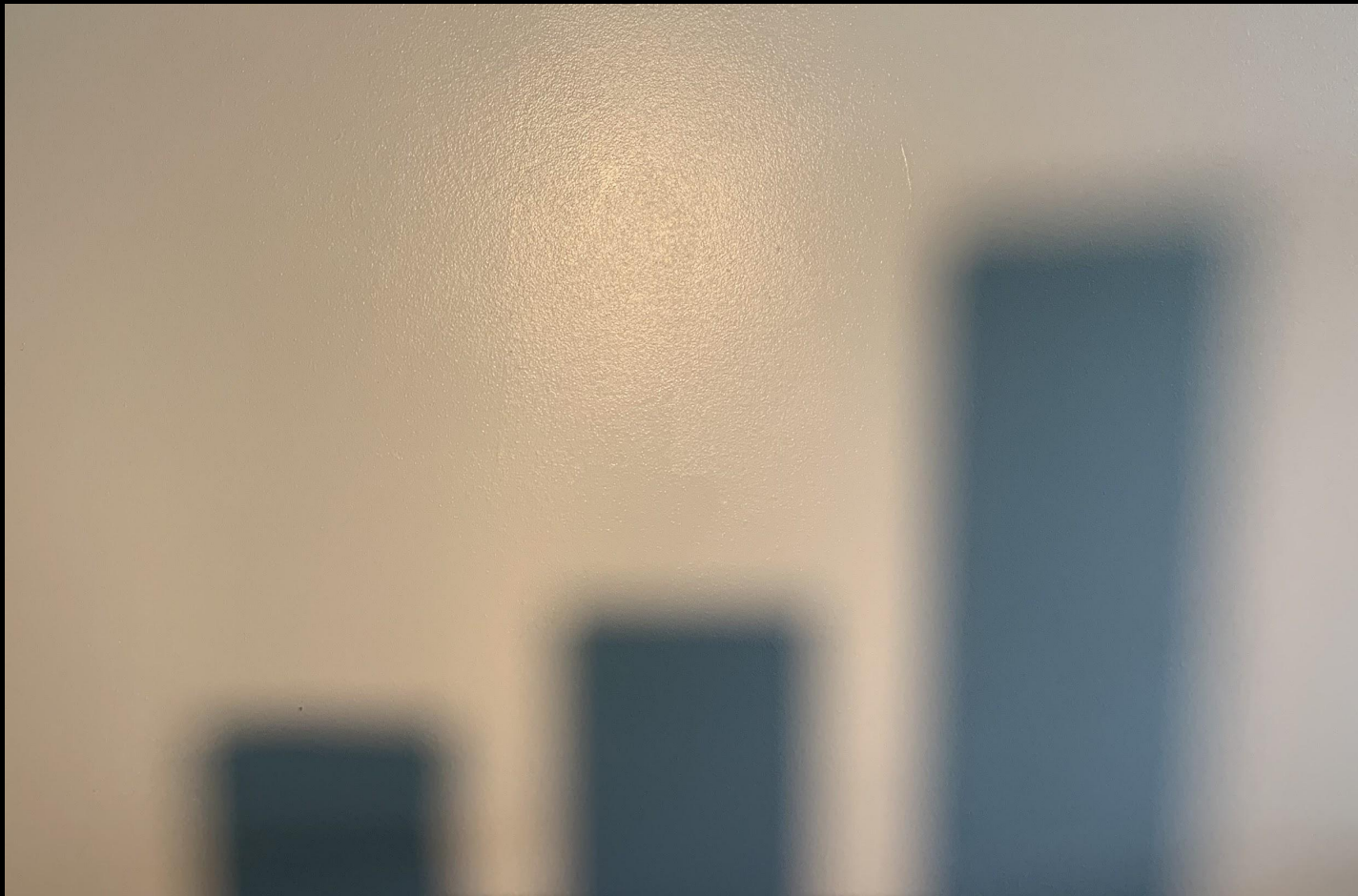


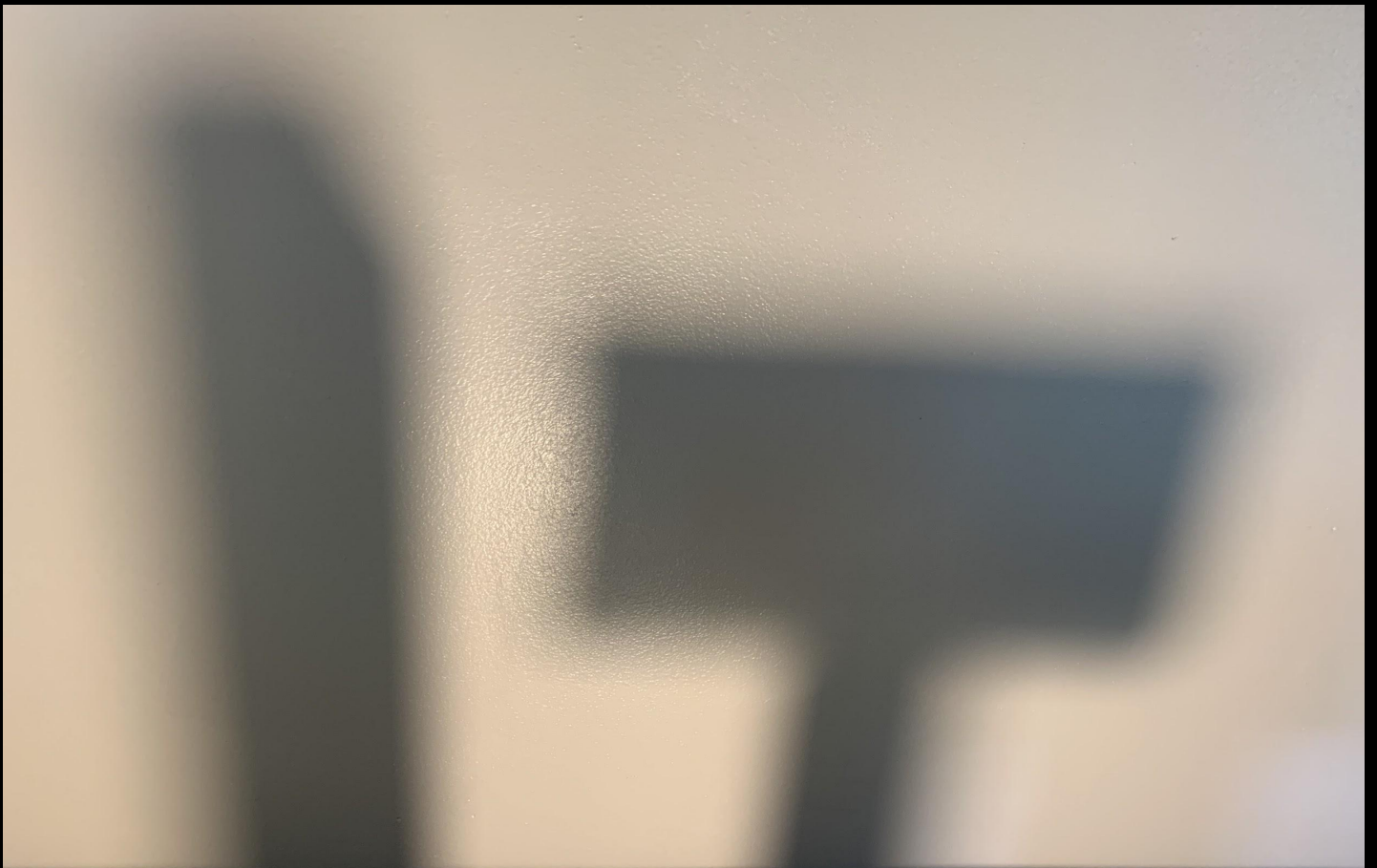
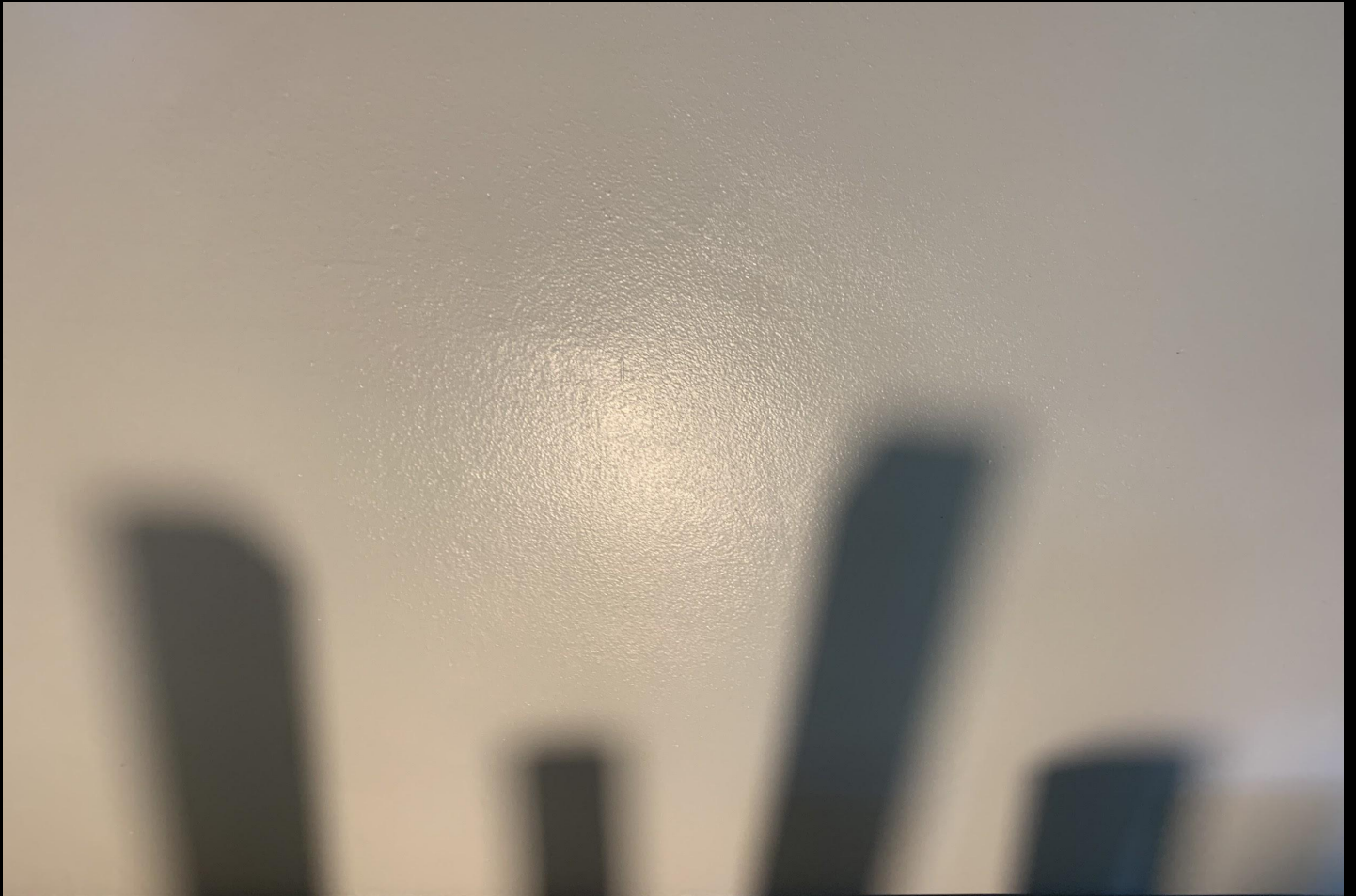
**Thermometer- an
instrument for measuring
and showing temperature**

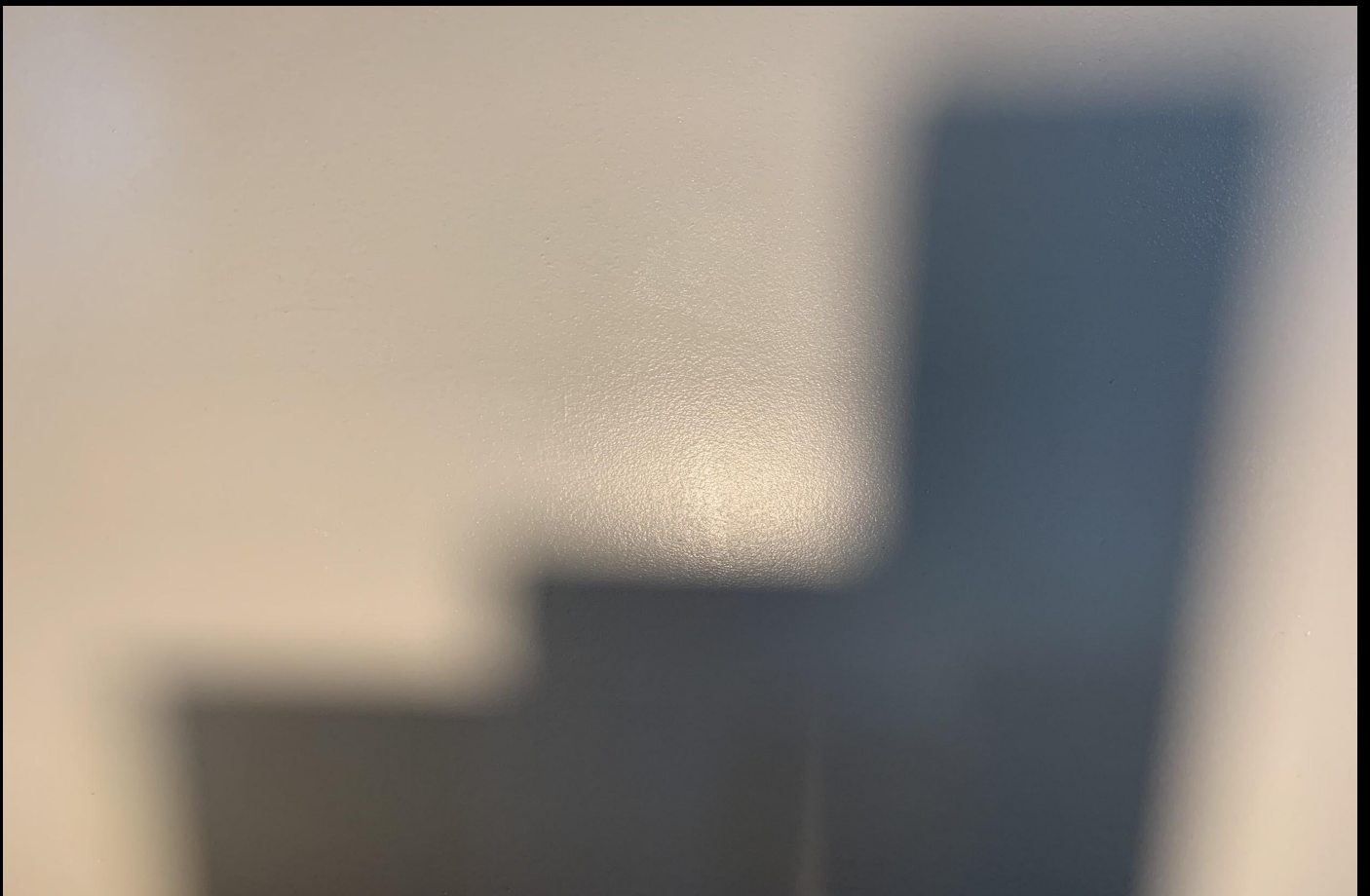
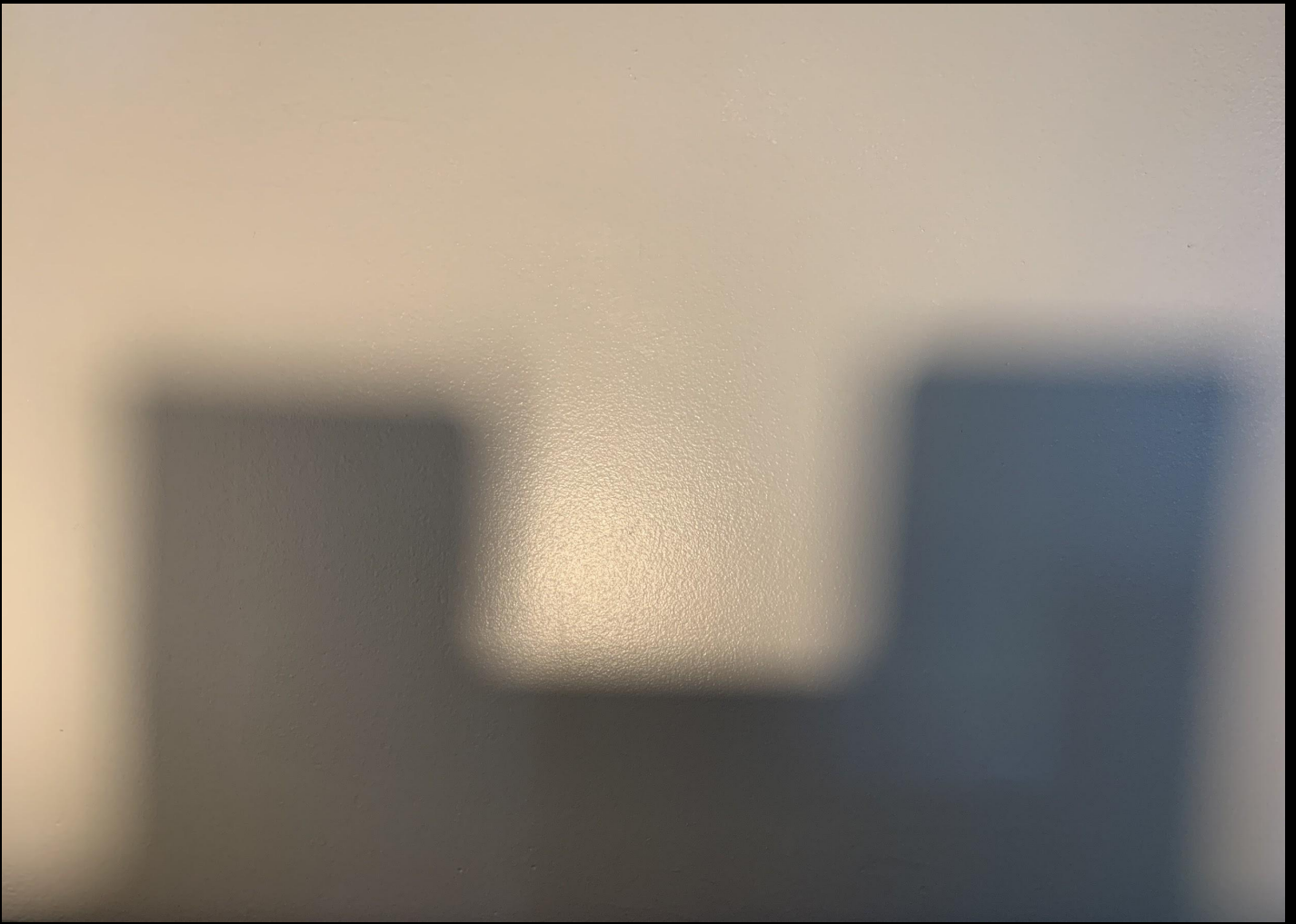
Day 1: Station 1

Cut these shapes out of cardstock for students to use to make shadows.









Investigation Book

Investigator: _____

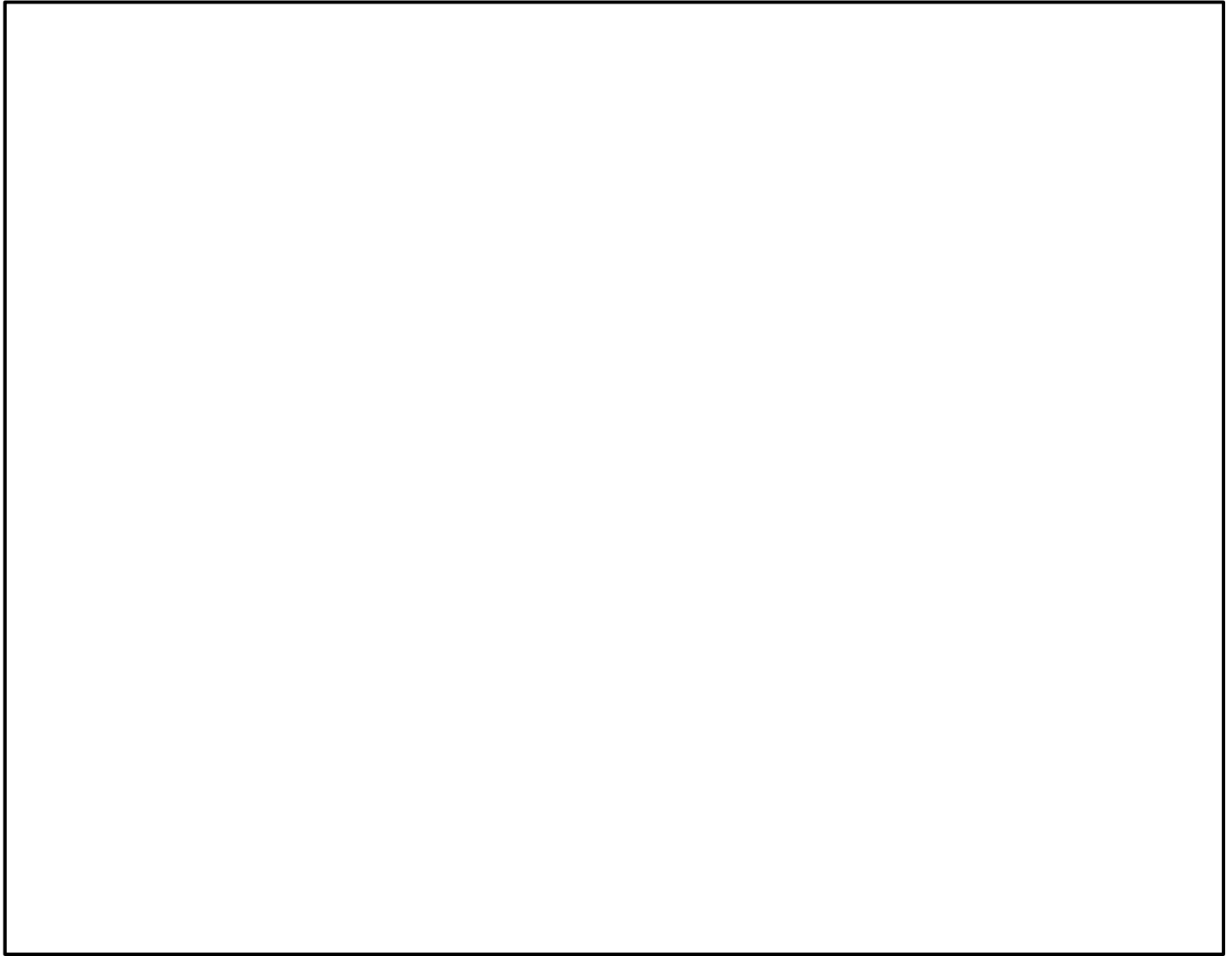


Institute

Inquiry-Based Learning
Educational Consultants

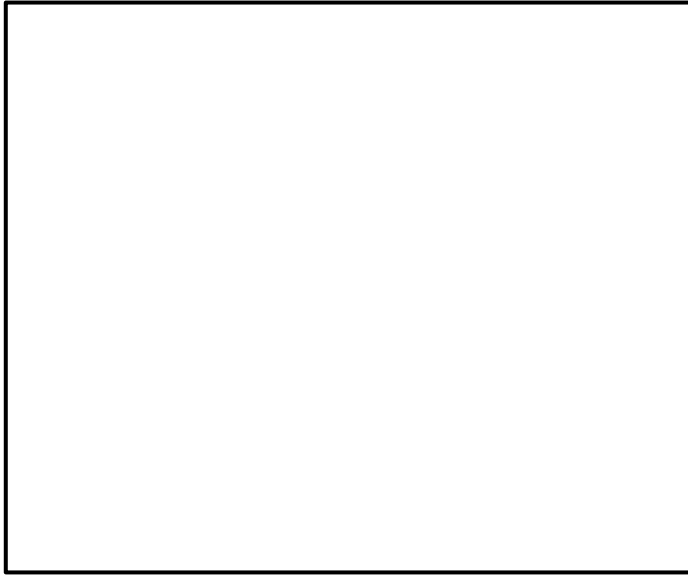
My Investigation

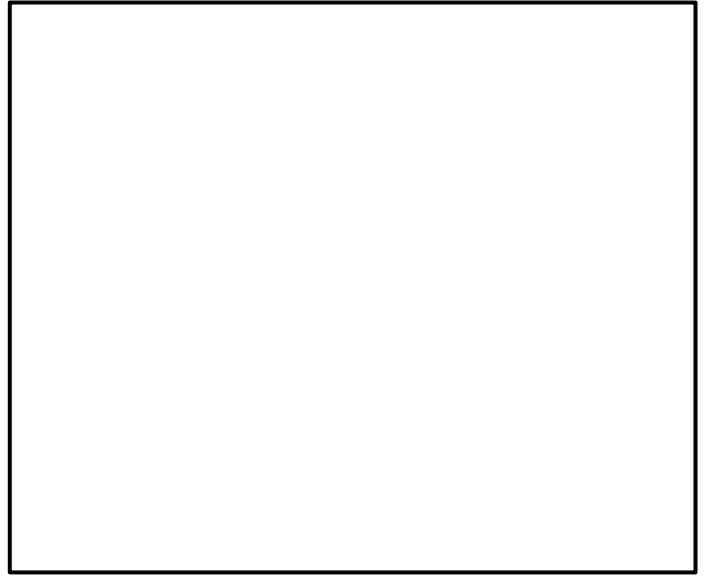
Draw a picture of you investigating your question.

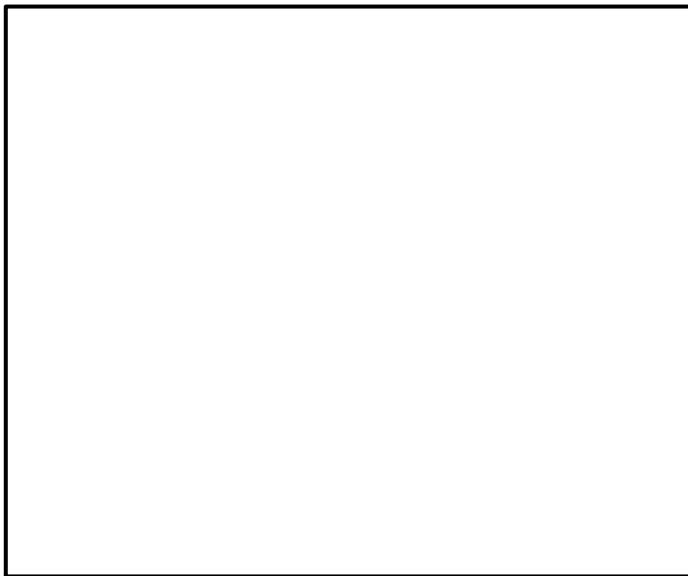


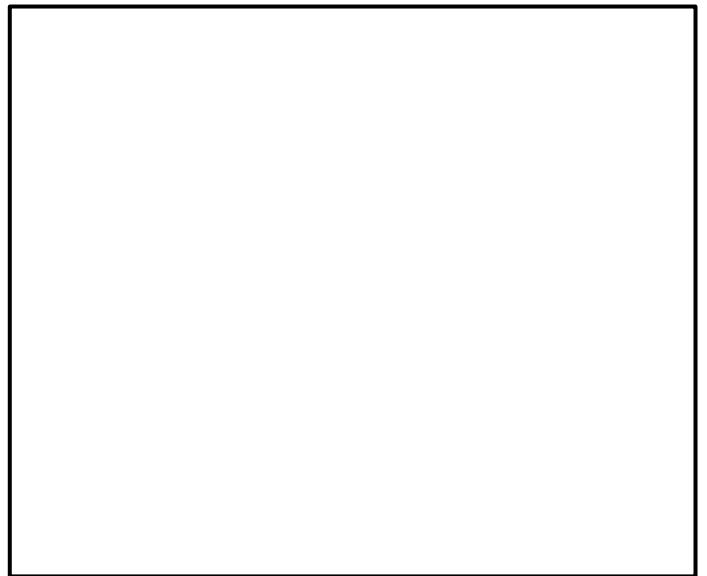
My Shadows

Draw what shadow you were trying to make and the shadow you created.

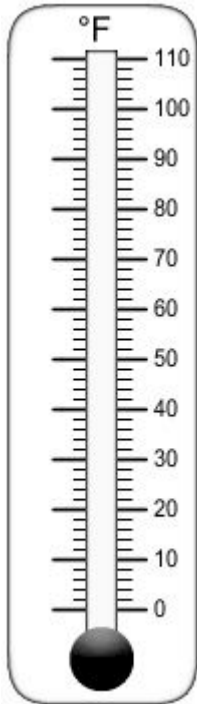
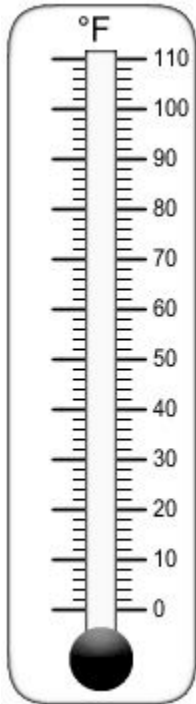








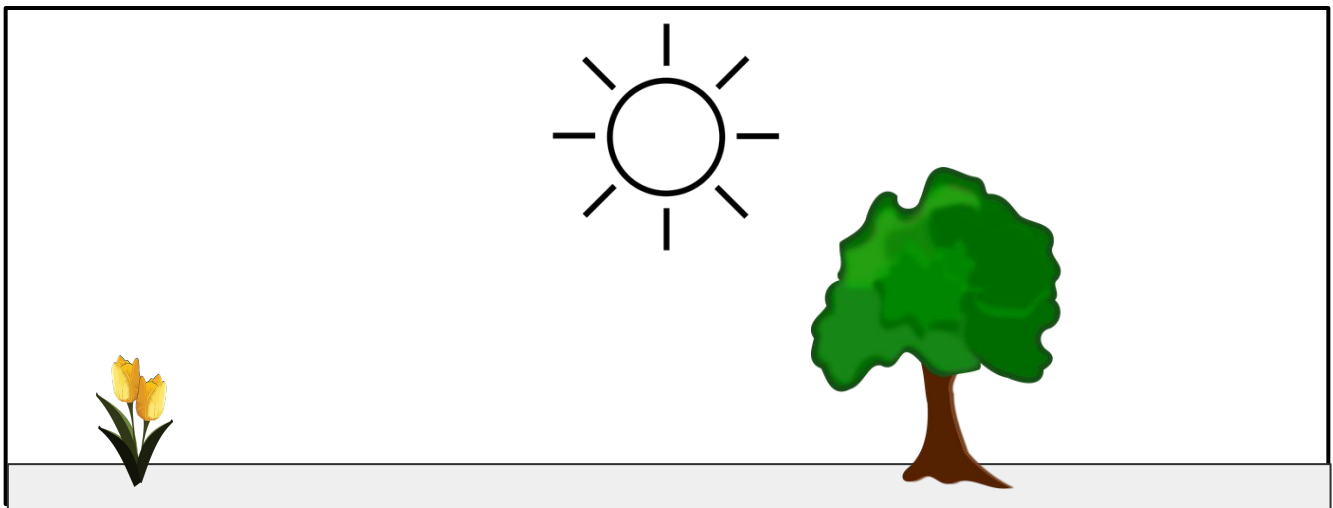
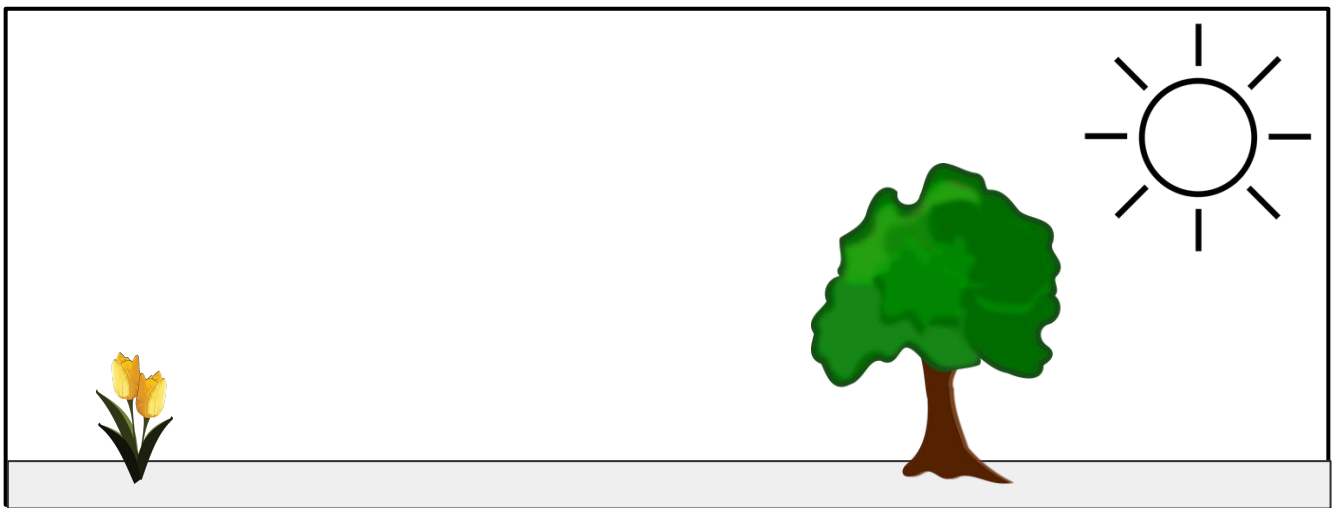
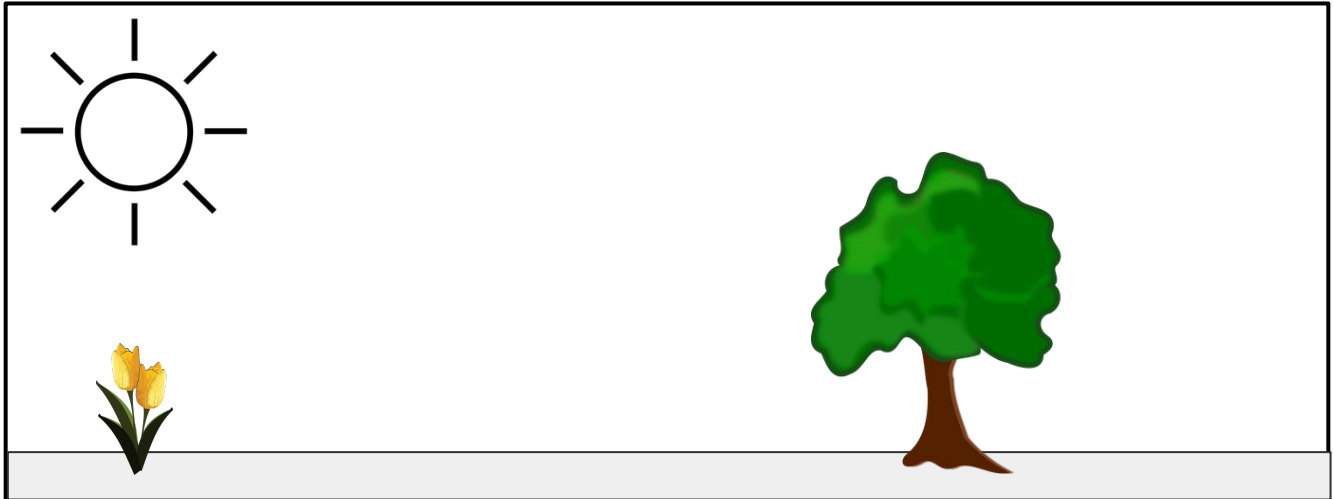
Shadows Outside

Temperature in Sunlight	Temperature in Shadow
	
°F	°F

It was warmer in the _____.

Name: _____

Draw where the shadows would be.



1. Did you learn new information about shadows?

Yes

No

2. Do you still have questions about shadows?

Yes

No

3. Was it fun and/or interesting?

Yes

No

1. What evidence suggests students grasped the major themes of the experiment?

2. Do you anticipate other guided or open inquiry projects arising from this project? What questions did the students ask that suggest understanding and interest in the subject?

3. To what extent did this project fit into your curriculum and teaching agenda?

4. Would you consider doing this again?

5. What would improve this experience?