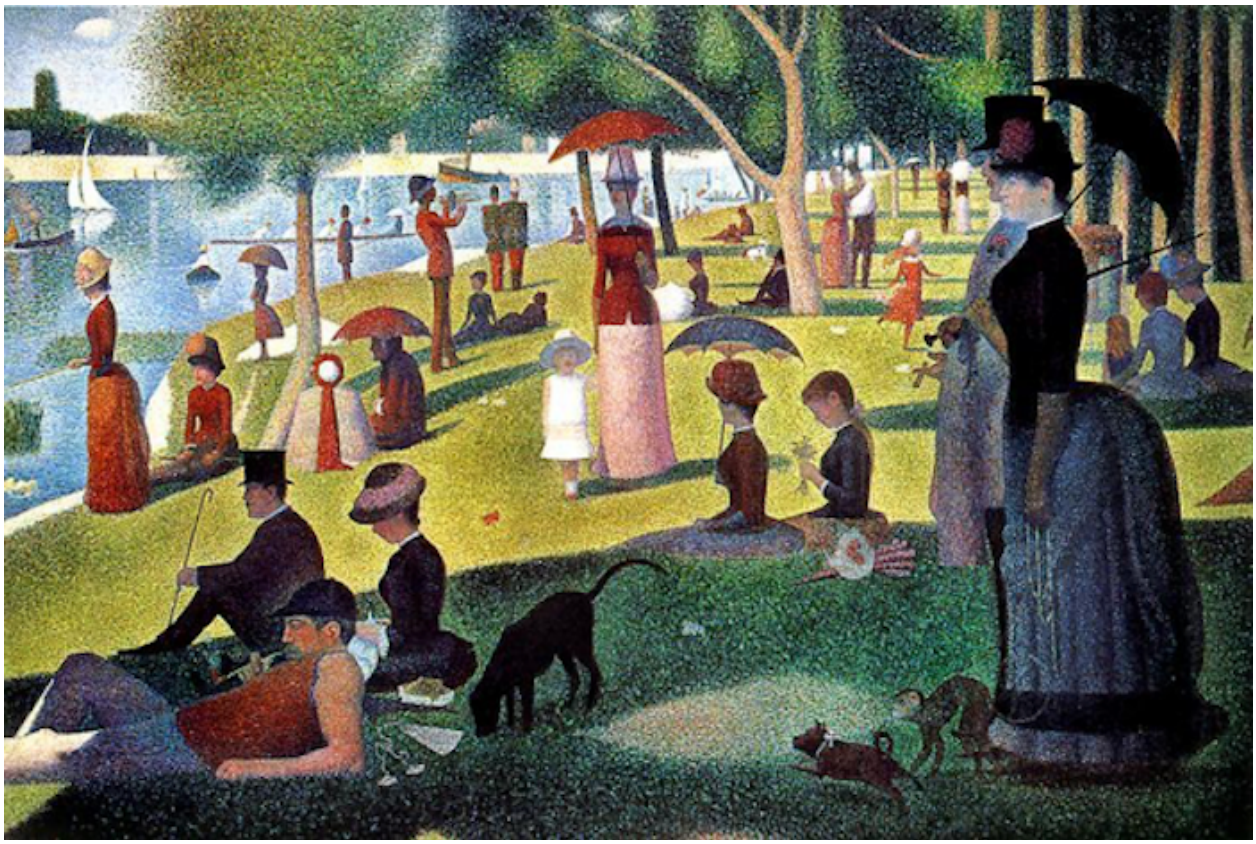
INVESTIGATION 1

Lesson Plan



INVESTIGATION FOCUS
Within the CELL, this Investigation is designed to:

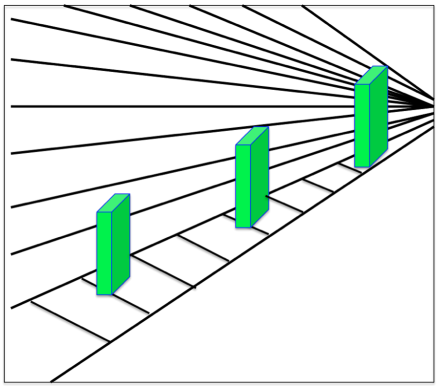
1. continue students' exploration of perspective.
2. provide students with an opportunity to investigate how perspective applies to a person's point of view.
3. help students understand that the description of objects or phenomenon is dependent upon a person's point of view.
4. show students' that an object's placement can be described in relative and absolute terms.
5. aid students' understanding that depiction of objects in a painting depends upon the artists' point of view.
6. Illustrate how artists use perspective to create a focus or feeling for their art.

RELEVANT BACKGROUND KNOWLEDGE

In Investigation Three, students complete their formal exploration of perspective. During the Pre-Lab, students will have an opportunity to apply what they have learned about perspective and depth perception by creating their own drawings. In addition, they will again discover how the use of vanishing point and perspective in art provide a very important lesson for us about human perception by viewing some optical illusions.

While we may see with our eyes, the meaning of what we see is dependent upon interpretation by our brains. Thus, our experience tells us that objects that are closer to us tend to be larger and that parallel lines tend to converge as they move further from us. In the real world, this allows us to judge distance, and the relative placement of objects in the world. Think, for example, of the importance of our brain being able to tell us that a ferocious animal that increases in size as we watch it is moving in our direction!

Since our brain interprets all that we see it is not too surprising that we can be "fooled" by optical illusions. The illustrations below are good examples:



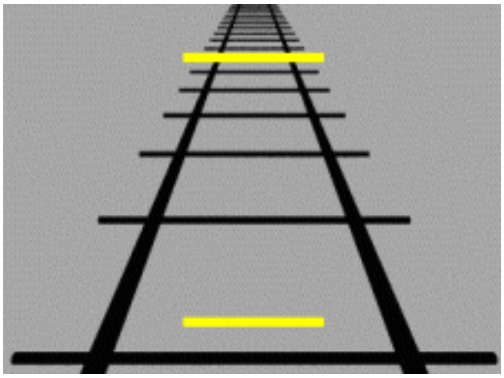


Figure 3.1: Examples of perspective optical illusions.

INVESTIGATION 3

In the left illustration, the rectangle is the same size in all three of the depictions. In the right illustration, the unattached horizontal lines are both the same length, although the lower line appears shorter. Such optical illusions work because the vanishing point of the drawing tells our brains that a distance is represented. Our brains then expect that the same object when viewed from further away should appear smaller. Since this is not the case for the rectangle or horizontal bars in these illustrations, our brain compensates by interpreting the size of the rectangle to increase from left to right and the horizontal bar to appear larger in the distance than is the foreground.

In addition to providing a review of perspective in relation to depth perception, Investigation Three also reacquaints students with the point of view aspect of perspective. Point of view can be described as the position of an observer in relation to an object they are observing. When observing an object, event or scene, the position or angle from which it is observed may strongly influence the way people perceive it. The same or similar object may be perceived quite differently if it is viewed from another point of view. In art, there are many different angles from which an artist may represent an object. Depending upon an artist's interpretation and point of view they choose to use, the artist can persuade the observer inadvertently to see an image as the artist wishes it to be seen. This tactic may be used not only by artists, but also in the media, film and even our daily conversations.

In Investigation Three, students will have the opportunity to view, describe and draw three objects from four different points of view. What they will discover is that the appearance and description of the objects in relation to one another (right, left, front, back) differ depending upon the location of the observer even though the objects are undeniably the same objects regardless of the observer's position in relation to them. While this concept is seemingly simple, it is an important concept to master. Understanding this concept provides a basis for understanding interpretation and observation and analysis of events not only in science and art, but also in all aspects of life.

Students complete their Investigation by relating the results of their experiments to the depiction of events and objects in a variety of pieces of art.

KEY SCIENCE TERMS AND CONCEPTS

1. **Depth perception:** The ability to see in three dimensions.
2. **Dimensions:** The measurements of an object such as its length, width and height.
3. **Eye:** The organ that contains all of the structures needed for sight.
4. **Field of view:** The entire area that is able to be seen at any one time.
5. **Image:** The appearance of an object produced by the reflection or refraction of light. An image of an object is formed on the retina when light passes through the lens of the eye
6. **Point of view:** The direction from which an object or scene is observed.
7. **Perspective:** The way in which objects appear in a person's view.

INVESTIGATION 3

PROCEDURAL TOOLBOX

Modeled Tools	New Tools	Previously Used Tools
		Volumetric Equipment Use and Operation

COGNITIVE TOOLBOX

Modeled Tools	New Tools	Previously Used Tools
		Apply *Look For* *Recall*

PRE-LAB

Supplies and Equipment:

Class materials:
1 *Perspective and Optical Illusions Presentation (located on the Art and Science CD)*
5 *Perspective Drawings (found at the end of Investigation One lesson plan)*

Individual materials:
1 *Scientist's Glossary*
1 *Scientist Data Record*

Procedure:

A. Begin the Investigation by reviewing what students learned about perspective, point of view and field of view in Investigations One and Two.

B.

Tool: **Recall**

Ask students: **What do we do when getting ready to learn something new?**
*Students should realize that the **Recall** tool is appropriate.*

Pose the following questions to prompt student recall about art and perspective.

1. **What do you think of when I say the word "perspective?"**
   Student answers may vary. However, their answers should reflect what they learned about perspective from Investigation One such as the way in which an object appears depending upon your point of view, the ability to produce a three dimensional image in two dimensional art work, or the change in the appearance of an object as the distance from the object changes.

2. **Imagine you are looking at a building up close and then later from farther away. Will the building look the same each time? Why or why not?**
   Students should indicate that the building will appear different when viewed close and farther away because the point of view has changed. In addition, the field of view changes and the part of the field of view that the object takes up changes as when viewed from different distances.

3. **How will the building look different? Why?**
   The building will look wider when it is closer because it takes up more of the field of view. The building will look more narrow when it is farther because it takes up less of the field of view.

4. **Complete the following statement: The smaller the visual angle either outside or inside the eye, the _____ the image of an object on the retina.**
   Students should answer: "the smaller the image of an object on the retina."

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C. Continue the review by encouraging students to apply what they have learned thus far by looking at some pictures and answering questions about those pictures.

1. Use the *Perspective and Optical Illusions Presentation* for this part of the Pre-Lab.

2. Use the **Teacher's Notes** section in the presentation to guide students through the questions and discussion.

3. The *Perspective and Optical Illusions Presentation* presents students with an opportunity to think about how the visual system uses the context clues of visual angles, and field of view to perceive depth and dimensions of objects. In addition, it also shows how those visual clues lead to a misconception of reality creating optical illusions.

Tool: **Apply**

Provide an opportunity for students to ***Apply*** what they have learned by creating their own drawings.

1. Explain that artists can create a feeling of depth or perspective in drawings by showing the differences in the appearance of near and far objects.
2. Encourage students to try their hand at creating perspective by creating a drawing. Tell students to turn to problem 1 in their *Scientist Data Record.* Review the directions that follow with the students and provide time for students to complete their drawings. If necessary, the completion of the drawings may be assigned as homework. Students will re-visit their drawings in the Pre-Lab of Investigation Four.
3. Draw a road that continues in the distance. Ask students: **Did the meter sticks appear to be parallel? Or did they appear to meet at their ends?**

   Students should indicate that the meter sticks appeared to meet in the distance. They did not appear to remain parallel.
4. Imagine that you are standing about 20 feet from the front of the road. Add some objects along the road. Add two trees to the drawing: one close to the "front" of the road, one at the end of the road (in the distance.)
   a. The tree in the distance should be a pine tree.
   b. The tree in the front of the road should be a deciduous tree such as a maple, oak, etc.
   c. Imagine that if the trees were standing next to each other, they would be the same height.
5. Add two houses to the drawing: one that is close to the viewer and one that is farther from the viewer.
   a. The house close to the viewer should have only one level.
   b. The house that is farther from the viewer should have two levels.
   c. Consider how tall the houses should be in comparison to the trees.

D. End the Pre-Lab by discussing perspective.

1. Tell students that in Investigations One and Two they focused on thinking about perspective in terms of perceiving depth and in terms of how the height and width of an object appears when it is at different distances from the eye.

2. Explain that during the lab in this Investigation, they will think about perspective in terms of point of view.

3. Ask students if they remember the five (5) drawings they created stories around from Investigation One. Remind students that each group created a different story because their drawings were from different points of view.

4. Show students the five *Perspective Drawings* again. Ask them to think about where a person might be standing when viewing each of the *Perspective Drawings.* Allow time for open discussion.

   Student answers may vary. Accept all answers that students can support with reason. Some sample answers are provided below.

   In Drawing A the person may have been standing next to or across from the person holding the balloon and talking to him or her.

   In Drawing B, the person may have been walking just in front of the person and the cat.

   In Drawing C, the person may have been standing next to or across from the person holding the birthday cake.

   In Drawing D, the person may have been kneeling on the ground directly in front of the cat or walking next to the cat.

   In Drawing E, the person may have been standing in front of the people holding the balloons and birthday cake.

5. After students have discussed differences in the points of view, explain they should think about how their point of view may affect how objects appear when they are conducting their experiments in the lab.

   Students should consider the following questions as they prepare for the lab.

   How does your perspective (point of view) affect the appearance of objects?

INVESTIGATION 3

LAB

Supplies and Equipment:

Class materials:
- Red food coloring
- Blue food coloring
- Yellow food coloring
- water

Group materials:
- 2 meter sticks
- 3 400 ml beakers
- 1 plastic dropper

Individual materials:
- 1 *Scientist Data Record*

Preparation:
1. Organize the required materials at a distribution point.
2. Divide students into cooperative groups of three.

Instruction:
1. Direct each student group to obtain the following necessary materials from the distribution point: two (2) meter sticks, three (3) 400 ml beakers, one (1) plastic dropper.

Procedure:

1. The trials in this Investigation focus on how objects appear from different points of view, including those objects that are near to the observer and those that are farther from the observer. Each trial includes steps that are used to set-up the experiment. In following the directions for set-up, students may be tempted to focus more on the steps of the procedure and less on the observations they will make after the experiment design has been prepared.

Tool: **Look For**

Ask students: **What will you Look For when observing objects in the Investigation?**
Students should indicate that they should observe how different objects appear from their point of view.

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2. Trials 1 and 2: In each trial, students will be asked to place three beakers of water (red, blue, yellow) at specific X and Y coordinates on the lab table and to observe the appearance of the beakers. However, the position at which each student in the group starts will not be the same. Students will orient themselves so that there are some students along each slide of the lab table as they begin the experiment. This starting position will be referred to as Position 1.

   As students observe each beaker, they should consider the color of water in each beaker, the position of each beaker on the table, the height of each beaker and the width of each beaker. They should also draw how the beakers appear in their *Scientist Data Record.* Once their drawings have been completed, students will be asked to rotate one seat in a clockwise direction (one seat to the left) and draw the beakers again from this new perspective. Students will have the opportunity to draw the beakers from all four sides of the lab table.

   After students have completed their drawings from all four sides of the lab table, they will move to the next trial in which the beakers will be placed at different positions on the table. Students should repeat the same procedure of observing and drawing the beakers from all 4 perspectives around the lab table before moving onto the next trial.

   Completion of these trials in conjunction with the Post-Lab discussion should help students see that although the position of the beakers on the lab table can be described in the same absolute x and y coordinates by all members of the group, their appearance relative to each other and to the viewer depends upon the observer's perspective or point of view. For example while one person may indicate that the beaker to the right contains red colored water, a person sitting at a different position at the table may indicate that the beaker to the right contains yellow colored water. Thus, the position, color, and dimensions of objects are affected by a person's perspective or point of view. In art, paintings of the same event may appear differently based upon the "viewers" perspective. In addition, the paintings illustrate how objects and events appeared from the artist's point of view or perspective.

   As students complete this trial, ask them to consider the following question:

   How does your perspective (point of view) affect the appearance of objects?

   How does each beaker appear from your perspective (point of view)?

3. Upon completion of the Investigation, permit enough time to clean up the lab and return the materials and equipment to their assigned locations.

POST-LAB ANALYSIS

Supplies and Equipment:

Class materials:
Trials 1 and 2 Drawings Presentation
What's Your Point of View? Presentation
Microscopes and Perspective Transparency

Individual materials:
1 *Scientist Data Record*

A. Begin this part of the Investigation by encouraging students to summarize their activities in the Lab. Prompt student discussion by posing the following questions:

   1. **What were the main questions we wanted to investigate in this lab?**
      Students should indicate that the questions were: How does your perspective affect the appearance of an object? How does each beaker appear from your perspective?

   2. **How would you summarize the types of experiments that you performed to investigate this question?**
      Students should indicate that they performed two trials. In both trials they set up an x and y axis on the lab table. They placed three beakers at specific x and y coordinates on the table. Each student in the group sat at one of the four sides of the table and drew the three beakers. Students then rotated clockwise around the table, drawing the beakers from each point of view.

B. Begin the analysis of the experiment by encouraging students to review and organize their data from Trial 1.

   1. Tell students to assemble into their lab groups and locate problem 3 in their *Scientist Data Record*. This problem encourages students to compare their drawing of the beakers from position 1 with the drawings of position 1 from other students.

   2. Explain that as students compare their drawings of the beakers at position 1 they should discuss the following questions within their group:

      a. Which beaker is in the front, back and middle of the paper?
      b. Which beaker is in the middle, right and left of the drawing?
      c. How big are the beakers? Are they the same size? Which are taller or shorter than the others? Which are wider or narrower than the other?

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3. Once students have compared their drawing ask them: **Did each of you give the same answers for all of the questions?**
   Students should indicate that they did not give the same answers for the questions. For example, one student may indicate that in position 1, the yellow beaker was in the front right, the blue in the middle back and the red in the left halfway back. The yellow beaker was the largest, the blue the smallest and the red a size in between the two. A second student may indicate that the blue beaker in the middle front, the yellow beaker in the left back and the red beaker on the right halfway between the blue and yellow beaker. (See the sample drawings in problem 3. Each of the drawings is position 1 for some of the students.)

4. Select one student to describe the drawing of his/her beaker and to show the drawing to the class. Ask students: **Does anyone else have a drawing from Position 1 that matches this?**
   Students should realize that at least one person in each group and maybe one other person within their own group will have a drawing similar to theirs. Students whose position 1 drawings were the same all started at the same position at the lab table. In other words, all of these students had the same point of view or perspective.

   a. Use the *Trials 1 and 2 Drawings Presentation to* show the *Trial 1 Position 1 Drawing* to students. Ask if this drawing matches the description given by the student.
      The student's drawing may or may not match the drawing on the slide depending upon his/her starting position. At least one quarter of the class should have a drawing for Position 1 that matches this drawing.

   b. Ask students: **How many have a drawing labeled position 1 that does NOT look like this?**
      Student answers may vary depending upon their starting positions at the lab table. At least half to three fourths of the class should have a drawing that does not match this drawing.

      - **How are your the drawings the same?**
        Students should indicate that all of the drawings included three beakers of different colors: red, blue and yellow. The drawings all included beakers that could be described using the terms left, right, middle, front and back.

      - **How are your drawings different?**
        Students should indicate that the location of the different colored beakers was not the same in each drawing. In addition, the size of the beakers was not the same in all of the drawings. For example, one student may indicate that in position 1, the yellow beaker was in the front right, the blue in the middle back and the red in the left halfway back. The yellow beaker was the largest, the blue the smallest and the red a size in between the two. A second student may indicate that the blue beaker in the middle front, the yellow beaker in the left back and the red beaker on the right halfway between the blue and yellow beaker.

c. Ask students: **Does anyone else have a picture that looks like this**? **Which position is it labeled in your drawing?**
Students should all indicate that they have a drawing that looks like the one shown in the Trial 1 Position 1 Drawing Slide. Students may have labeled it positions 2, 3, or 4 depending upon when in their rotation they observed the beakers from that point of view.

d. Ask students: **Why do we all have a drawing that looks the same but may be labeled with different position?**
Students should indicate that they all viewed the beakers from that particular point of view or perspective at some time during their rotation around the lab table. However, since they all started at different places at the lab table for the trial, the way the beakers appeared in this drawing may not have been in "position 1" for their rotation.

e. Encourage students to reflect on what they have discussed by answering problems 3a-d in their *Scientist Data Record.*

f. Repeat the above steps for positions 2, 3 and 4. Use the *Trial 1 Positions (2,3 4) Drawing Slides* to aid in the process.

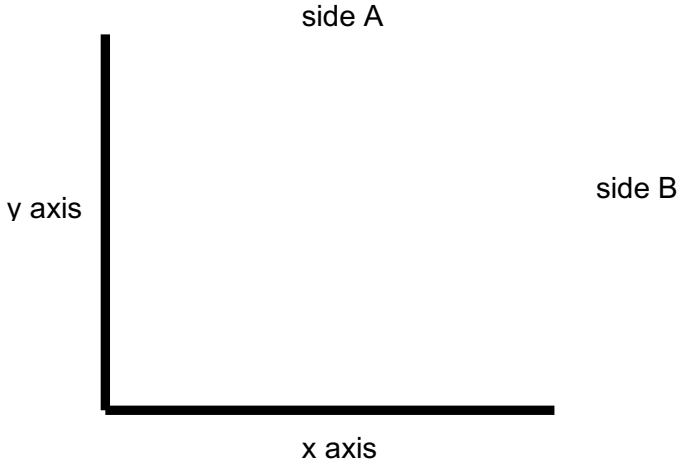
g. Once students have compared the drawings from all of the positions, discuss question 3e found in problem 3 in their *Scientist Data Record.* **Compare your drawings for positions 2, 3 and 4 for Trial 1. How did your perspective affect how you described the color and size of the beakers?**
Sitting at different positions around the table resulted in a different point of view or perspective. When observing the beakers, this meant that different beakers were in the center, right and left of my field of view at each of the four locations around the table. It also meant that different beakers were different distances from my eyes (front, middle, back) at each of the four locations around the table. The closer the beakers were to my eyes for a particular point of view, the larger they appeared. The farther the beakers were to my eyes for a particular point of view, the smaller they appeared.

INVESTIGATION 3

5. Begin to analyze the results from Trial 2. Ask students: **Do you think we will make similar observations about the drawings in Trial 2? Why?**

6. Explain that in analyzing Trial 2, you'd like to play a game with students.

   a. Draw the following diagram on the board. Remind students that this is how their lab table appears during the lab.

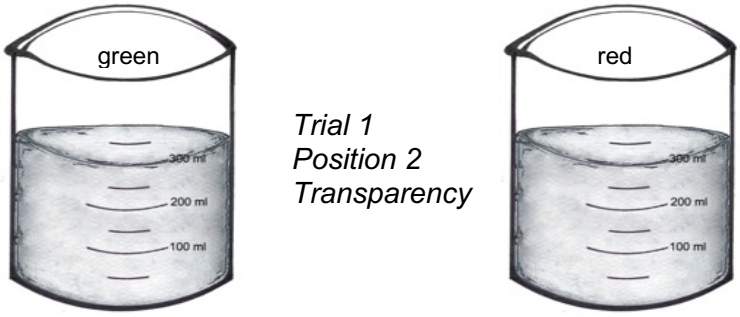


   b. Tell students that you will show them a drawing of the beakers. Use the *Trial 2 (positions 1-4) Drawing Slides (*from the *Trials 1 and 2 Drawings Presentation).* When the drawing is shown, they need to:

   - Raise their hands if they have a drawing that matches.

   - Indicate by using the terms from the drawing of the lab table on the board their position at the lab table when the drawing was made. In other words, was their point of view (perspective) from the x-axis, the y-axis, side A or side? *A sample of how the game is shown below.*

   - Students will likely find it helpful to look at the grid containing the x and y coordinates of the beakers in problem 4 as they play the game.



Trial 1
Position 2
Transparency

Students should indicate that this perspective is that from sitting along SIDE A.

c. After the game has concluded encourage students to discuss and answer questions 4 and 5 in their *Scientists Data Record.*

- **Compare your drawings for Trial 2. How did your perspective affect how you describe the color and size of the beakers?**
  Sitting at different positions around the table resulted in a different point of view or perspective. When observing the beakers, this meant that different beakers were in front of or next to each other of my field of view at each of the four locations around the table. For example, in position 1 the blue beaker was directly behind the yellow beaker. As a result, it appeared as if there were only one beaker in that position with the color green. Looking through the yellow beaker to the blue beaker in back of it created the appearance of one green beaker. However, for position 2, the blue beaker was directly behind the red beaker. Looking through the red beaker to the blue beaker in back of it created the appearance of one purple beaker.

  It also meant that different beakers were different distances from my eyes (front and back) at each of the four locations around the table. The closer the beakers were to my eyes for a particular point of view, the larger they appeared. The farther the beakers were to my eyes for a particular point of view, the smaller they appeared.

- **The directions for Trials 1 and 2 indicated that beakers were to be placed at specific x and y coordinates on the lab table. Why do you think x and y coordinates were used instead of the directions of "right," "left," and "middle?"**
  Students should indicate that the description of left, right, middle, front and back are relative to their location or point of view. As their point of view around the table changed, the beakers in the positions of right, left, middle, etc. also changed. However, the x and y axis were labeled, and these axes remained the same when rotating around the table. Therefore, the x and y coordinates for each beaker were the same regardless of where a person sat at the table.

7. End this portion of the analysis by discussing how artists make use of differences in perspective or points of view. Show students the *What's Your Point of View? Presentation.* Students will have the opportunity to describe objects from different points of view as well as view paintings from artists portrayed from different perspectives.

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C. Conclude the Post-Lab by inviting students to think about how what they've learned about perspective thus far can be applied not only to art by science.

1. Tell students to imagine the following: A man places a wood block on a table. He attaches a spring scale to the block and pulls the block from one end of the table to the other. Ask students: **What do you think the man was studying?**
   Student answers may vary.

2. Explain that while the man was pulling the block along the table, a woman was timing how long it took the block to move from one end of the table to the other. Ask students: **What do you think the woman was measuring?**
   Student answers may vary.

3. Continue by telling students to imagine that the procedure was done again, this time there was a sensor place on the bottom of the block. After the block was slid across the table, a second woman obtained information from the sensor about the heat that was produced as the block slide across the table.

4. Discuss with students that each of the descriptions above come as one part of an experiment was carried out. Yet the perspective of each of the three people studying the event was different. One man was focused on the force of friction. One woman was focused on the velocity of the block. The other woman was focused on the heat produced in the reaction.

5. Continue by showing students the *Microscopes and Perspective Transparency*. This transparency gives another example of differences in perspective in science. Three different views of an elodea leaf are illustrated on the transparency. The three different views come as a result of viewing the same leaf specimen with three different microscope objectives and therefore at three different powers of magnification.

6. End this part of the discussion by asking students to complete problem 6 in their *Scientist Data Record.* Students may answer using the examples previously discussed or may choose to think of their own example.