Instructor Data Record

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Scientist's Glossary

Tool: **Rehearsal**

1. **Depth:** How deep something is. Depth may be described differently from different perspectives. It may be the distance or measurement from the top of an object to its bottom, from its front to back, or from its outside to its inside.
2. **Depth perception:** The ability to see in three dimensions.
3. **Dimensions:** The measurements of an object such as its length, width and height.
4. **Eye:** The organ that contains all of the structures needed for sight.
5. **Field of view:** The entire area that is able to be seen at any one time.
6. **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.
7. **Point of view:** The direction from which an object or scene is observed.
8. **Perspective:** The way in which objects appear in a person's view.
9. **Retina:** The lining in the back of the eye where images formed by the lens are focused.
10. **Vanishing point:** A point in a drawing, painting or in space at which parallel lines seem to meet. A point in space at which objects seem to disappear.
11. **Visual angle:** The angle at which light from an object enters the eye. The visual angle can be measured either as light enters the eye or inside the eye when light is focused on the retina.

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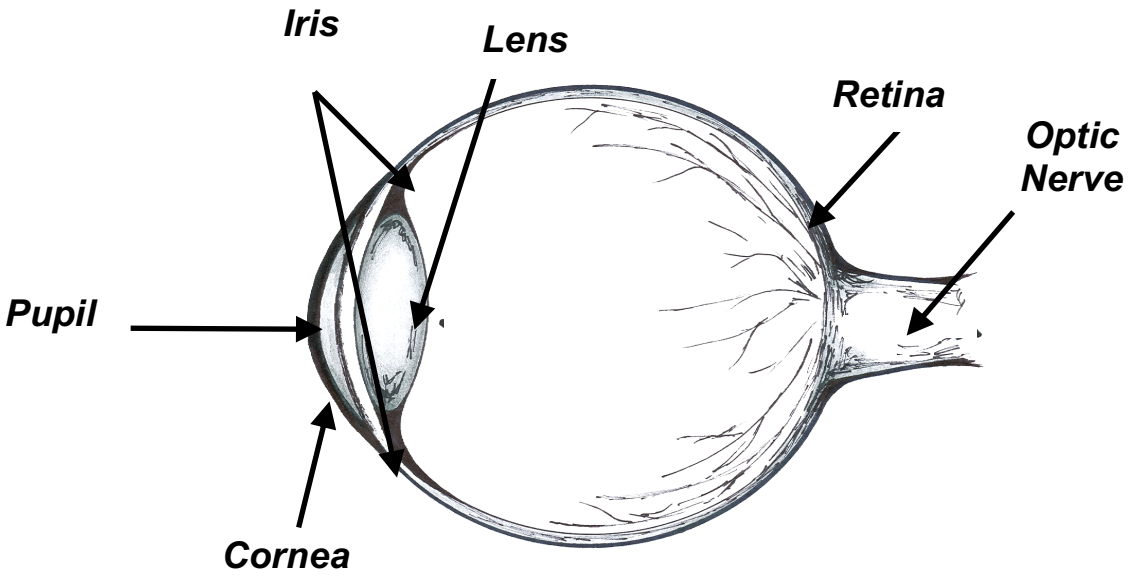
Name:

1. Look at the picture. It shows a cross section of the eye.

   a. Read the paragraph below and then label the parts of the eye.

   b. Draw a dotted line to show the path that light takes as it enters the eye.



Light reflects off of an object and passes through the outer layer of the eye, called the cornea. Light then enters the eye through an opening called the pupil. The size of the pupil is controlled by the iris, which is the colored part of the eye.

Light from the object then passes through a lens that focuses the image of the object onto a structure in the back of the eye called the retina. Cells in the retina convert the light falling on them into nerve signals that are carried by the optic nerve to the brain.

The brain then interprets these signals allowing the identification of the object.

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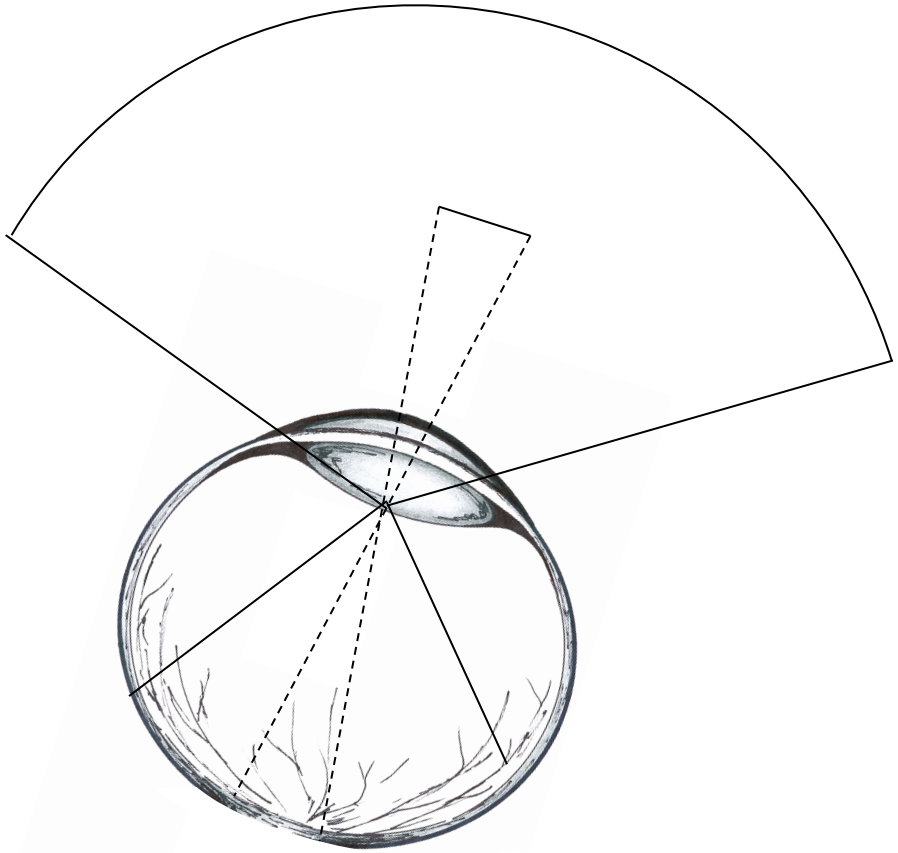
2. The diagrams below model the right eye, its field of view, and an object. They also model the images of the field of view and the object on the retina.

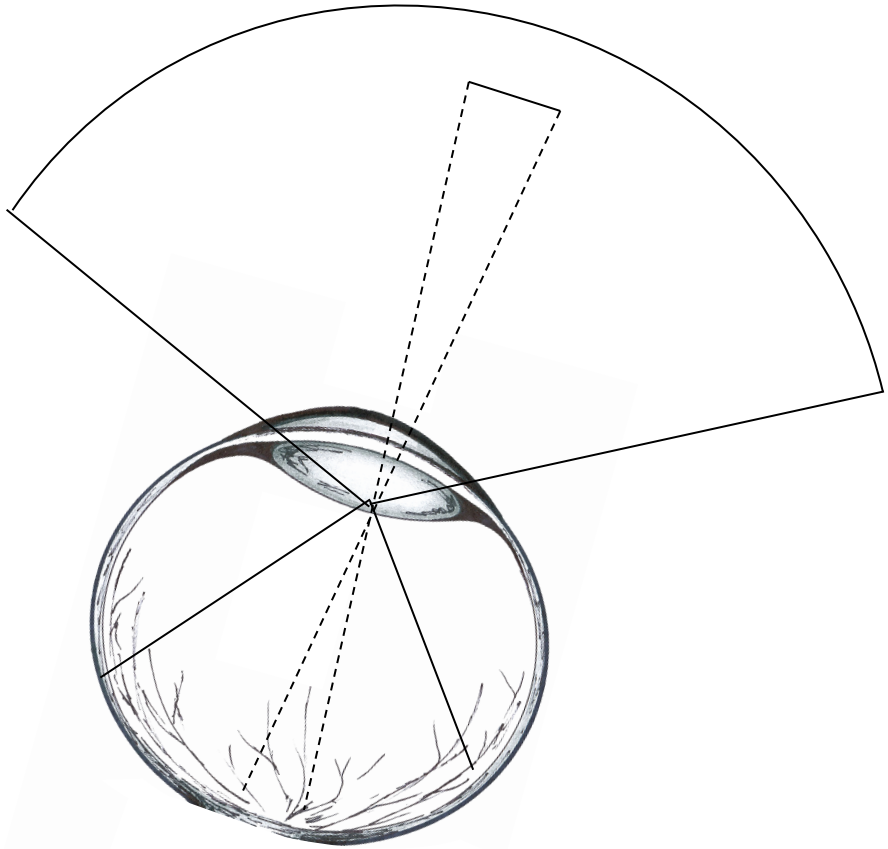


Wood block 2.5 cm from eye

Width of image on retina= ***1.2 cm***

Field of view on retina= ***5 cm***

Object/Field of view = ***0.24 cm***



Wood block 5 cm from eye

Width of image on retina= ***0.8 cm***

Field of view on retina= ***5 cm***

Object/Field of view = ***0.16***

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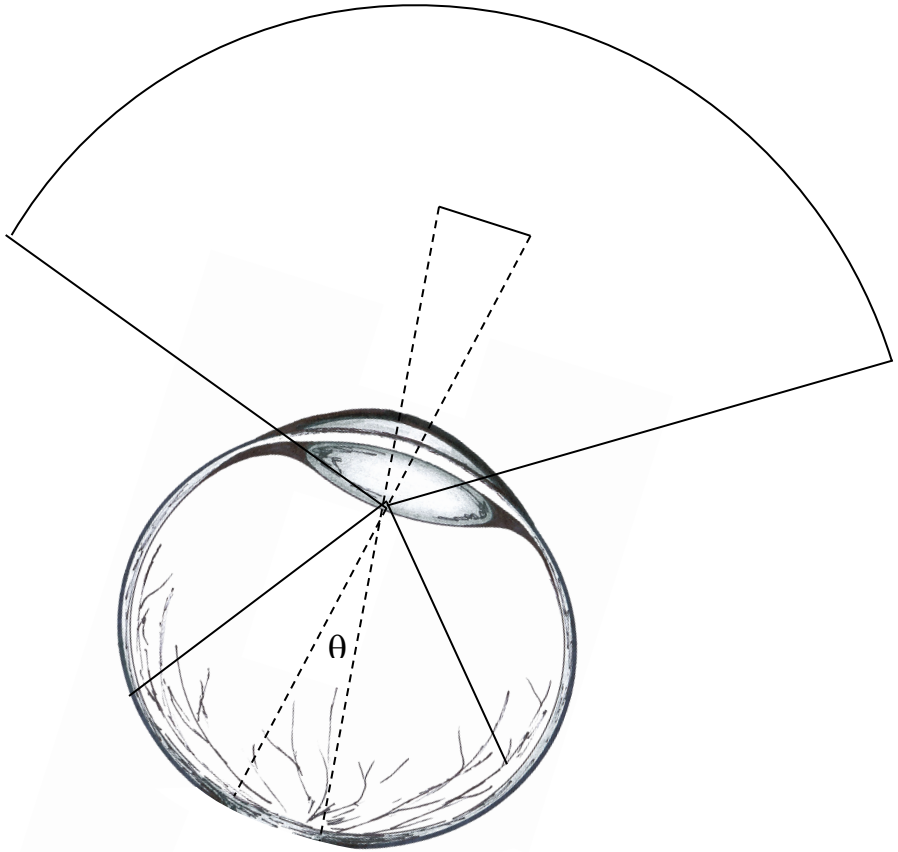
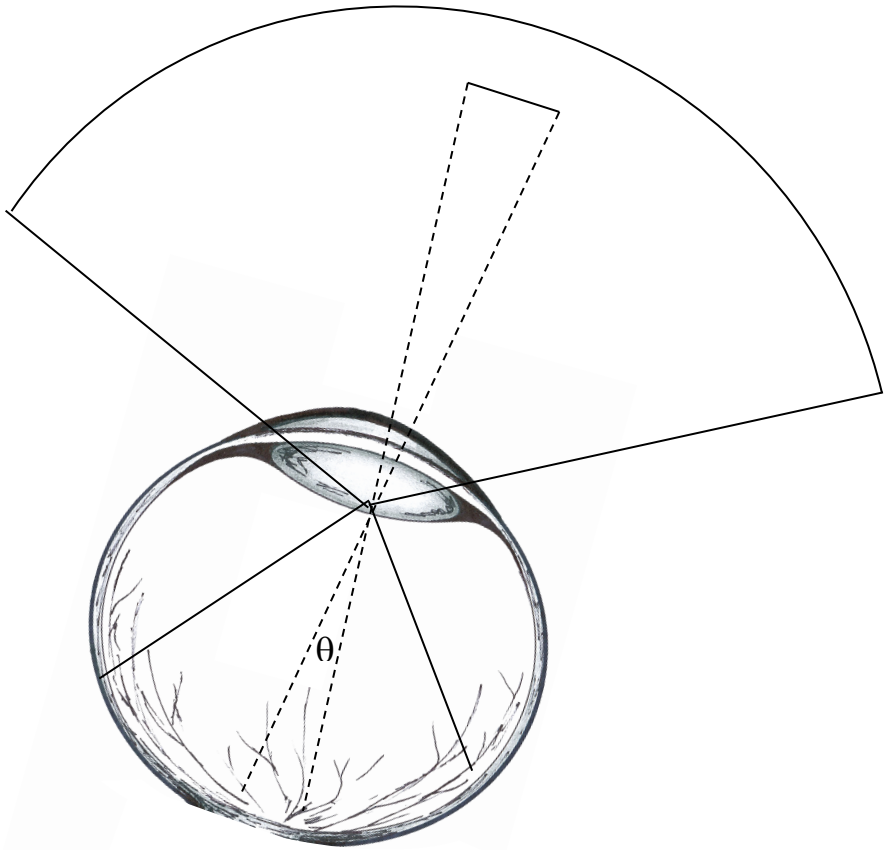
3. The **visual angle** is the angle formed at the retina by light from an object entering the eye. Use a protractor to measure the **visual angle** of the image of the wood block when it was different distances from the eye. The diagrams below model light entering the right eye.



Visual angle = ***18°***



Visual angle = ***12°***

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4. Look at the visual angles and the object/field of view ratios. Can you see any pattern? Circle the correct choices in the sentences below.

Tool: **Rules**

Objects that are closer to the eye appear larger because they take up (less, ***more)*** of the field of view and have a (smaller, ***greater***) visual angle on the retina.

Objects that are farther from the eye appear smaller because they take up (***less,*** more) of the field of view and have a (***smaller,*** greater) visual angle on the retina.

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5. Trial 1: Does the distance from which an object is viewed change its appearance?

   a. In this trial you will compare the appearance of an object when it is different distances from your eye.

   b. In Investigation 1, you compared how parallel lines and a wood block when viewed from different distances. Think about what you discovered and make the following predictions.

Tool: **Prediction**

- Will the width of the object be the same when viewed from different distances?

  Based upon their findings from Investigation One, students should predict that the width of the object will change when viewed from different distances.

- Will the height of the object be the same when viewed from different distances?

  Student answers may vary. However, based upon their observations that the width of an object changes as its distance from the eye changes, students should predict that the height of an object may change as the distance of the object from the eye changes.

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c. Locate one of the narrow ends of the lab table. Place a meter stick on the lab table so it extends from the narrow end to the center of the table. The 0 cm end should be at the edge of the narrow end.

d. Compare the height and width of a 50 ml centrifuge tube at different distances from your eye.

- Place the centrifuge tube at the 0 cm mark.

- Sit directly in front of the 0 cm mark of the ruler so that you are looking down the length of the meter stick.
- Place a metric ruler at the edge of the table.
- Move so that you can place your nose at the other end of the metric ruler. You should now be sitting 30 cm from the edge of the meter stick and centrifuge tube.

- Measure the height and width of the centrifuge tube. You will need to close one eye to do this. Record the height and width in the Table A.
- Stay where you are. Another student should move the centrifuge tube to the 20 cm mark. Measure the height and width of the centrifuge tube. Record the height and width in the Table A.
- Repeat the procedure and measure the height and width of the centrifuge tube when it is at the 40 cm, 60 cm, 80 cm and 100 cm marks of the meter stick. Record the measurements in the Table A.
- Were the measurements the same at all of the distances?
  Students should indicate that the measurements for height and width of the centrifuge tube were different at different distances from the eye.

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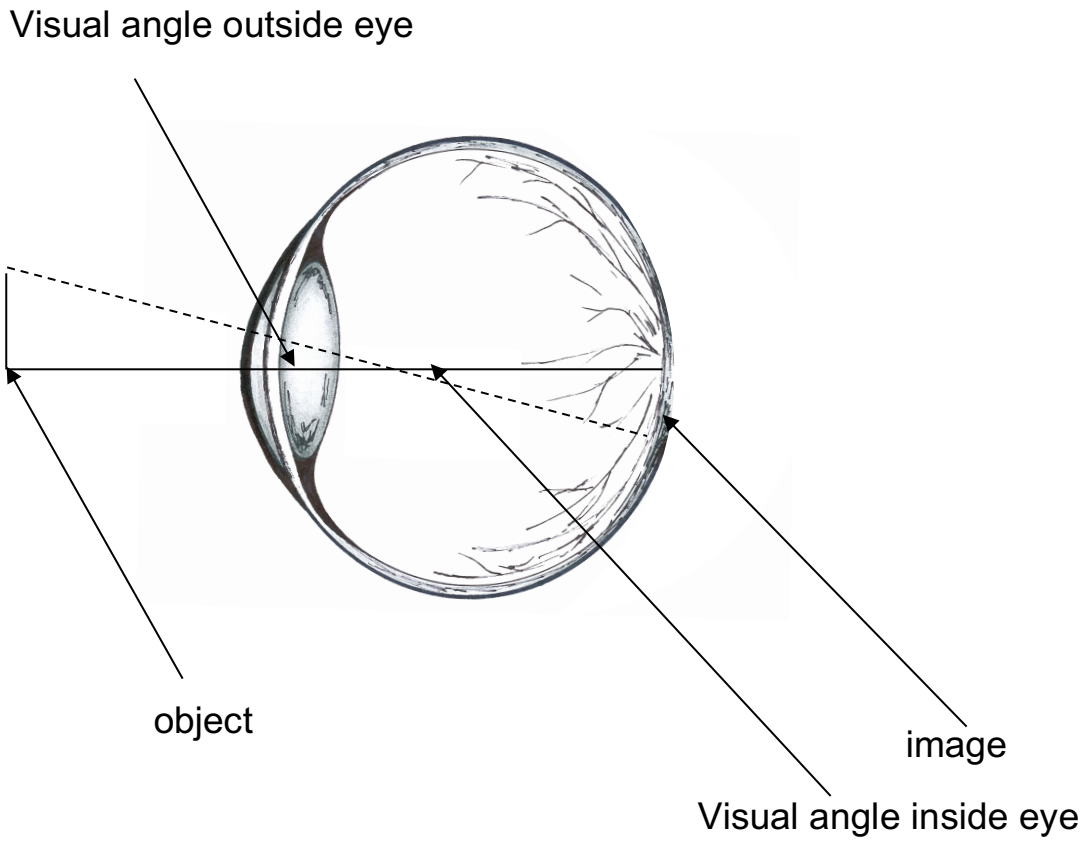
6. Trial 2: What is the relationship between the distance from an object and how its height appears?

   a. In this trial you will measure the part of the field of view an object occupies. You will do this by measuring the **visual angle of light ENTERING the eye.** This is the angle at which light from the object **enters** the eye.

      Measuring the visual angle OUTSIDE the eye is a way of ESTIMATING the visual angle of the image on the retina. The diagram below shows the visual angles outside and inside the eye.



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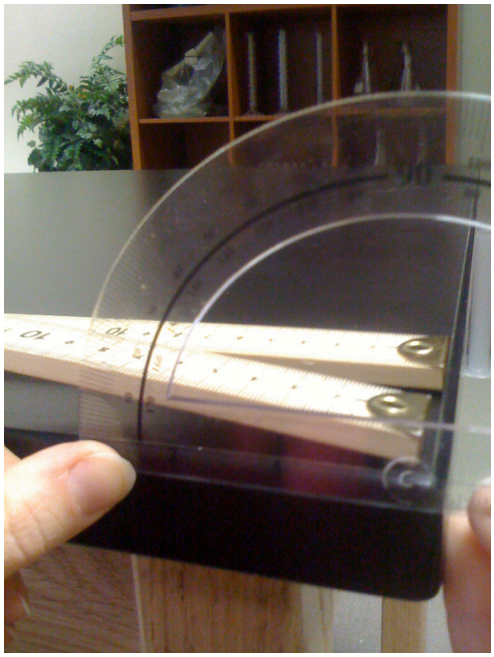
b. Measuring the visual angle outside the eye.

- Read the steps and use the picture to help you.
- Move the meter stick so that it is positioned closer to the center of the lab table. The 0 cm end should still be at the edge of the narrow end of the table.
- Place the centrifuge tube at the 100 cm mark.
- One student should hold the centrifuge tube in place.
- A second student should hold another meter stick so that the 0 cm end touches the 0 cm end of the first meter stick AND the other end touches the top of the centrifuge tube.



- A third student should use the protractor to measure the angle between the table and the meter stick that is touching the centrifuge tube.
- To measure the angle, the 0 mark on the protractor should be at the vertex of the angle. The horizontal line on the protractor should line up with the edge of the table. Observe where the meter stick that is touching the tube crosses the curve of the protractor. Record this number as the visual angle outside the eye.
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- Record the angle in Table A.
- Move the centrifuge tube to the 80 cm, 60 cm, 40 cm, 20 cm and 0 cm marks.

- Record the visual angle for each position in the Table A.
- You should find that the angle for the centrifuge tube at the 0 cm mark is 90°.

Table A

Position along meter stick	Height centrifuge tube appears (cm)	Width centrifuge tube appears (cm)	Visual angle (°)
0 cm	***11***	***2.6***	***90***
20 cm	***6***	***1.5***	***29***
40 cm	***5.5***	***1.5***	***16***
60 cm	***4***	***1***	***13***
80 cm	***4***	***1***	***9***
100 cm	***3***	***0.5***	***7***

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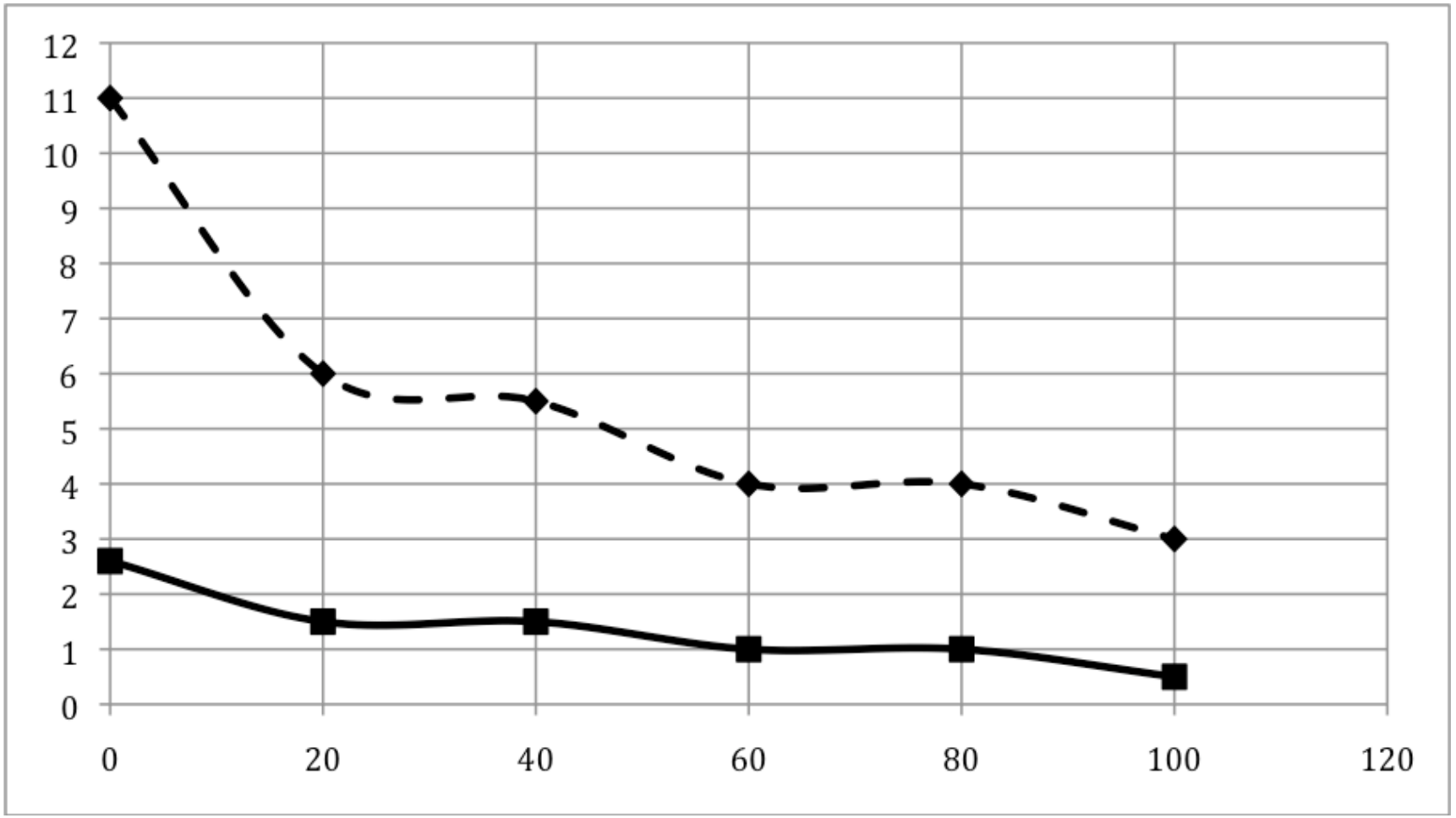
7. Complete a line graph that shows how the height and width of the centrifuge tube changed as it moved farther from the eye.

Use a solid line to connect the data points that show the width of the centrifuge tube.

Use a dotted line to connect the data points that show the height of the centrifuge tube.



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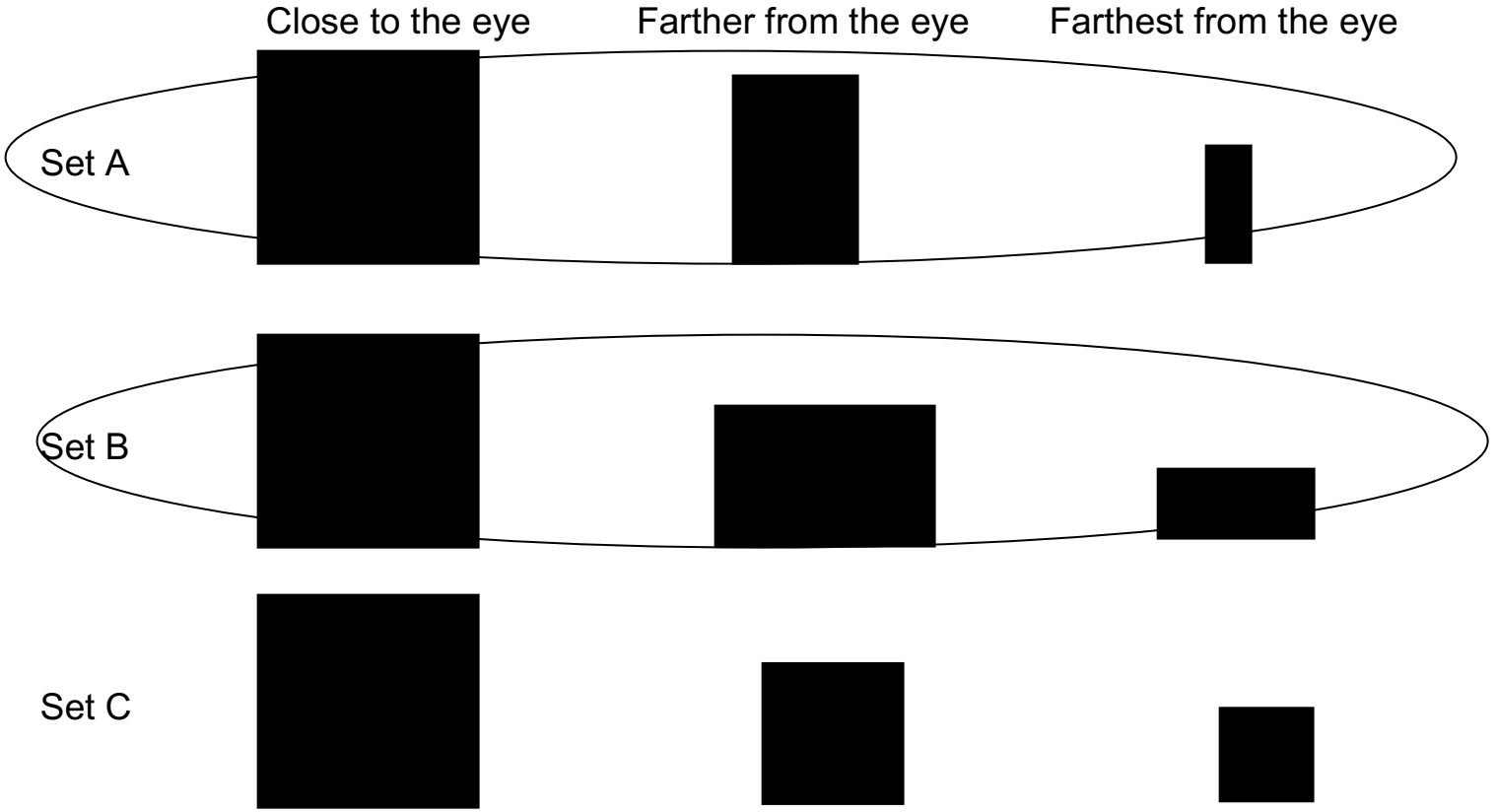
8. What happened to the height and width of the centrifuge tube as it moved farther from the eye?

Both the height and width of the centrifuge tube decreased as the tube moved farther from the eye.

9. Look at the three sets of pictures. Which TWO sets are NOT correct? Why? (Hint: Look at your graph above. Look at how the lines compare to each other. Is the pattern the same for height and width?)



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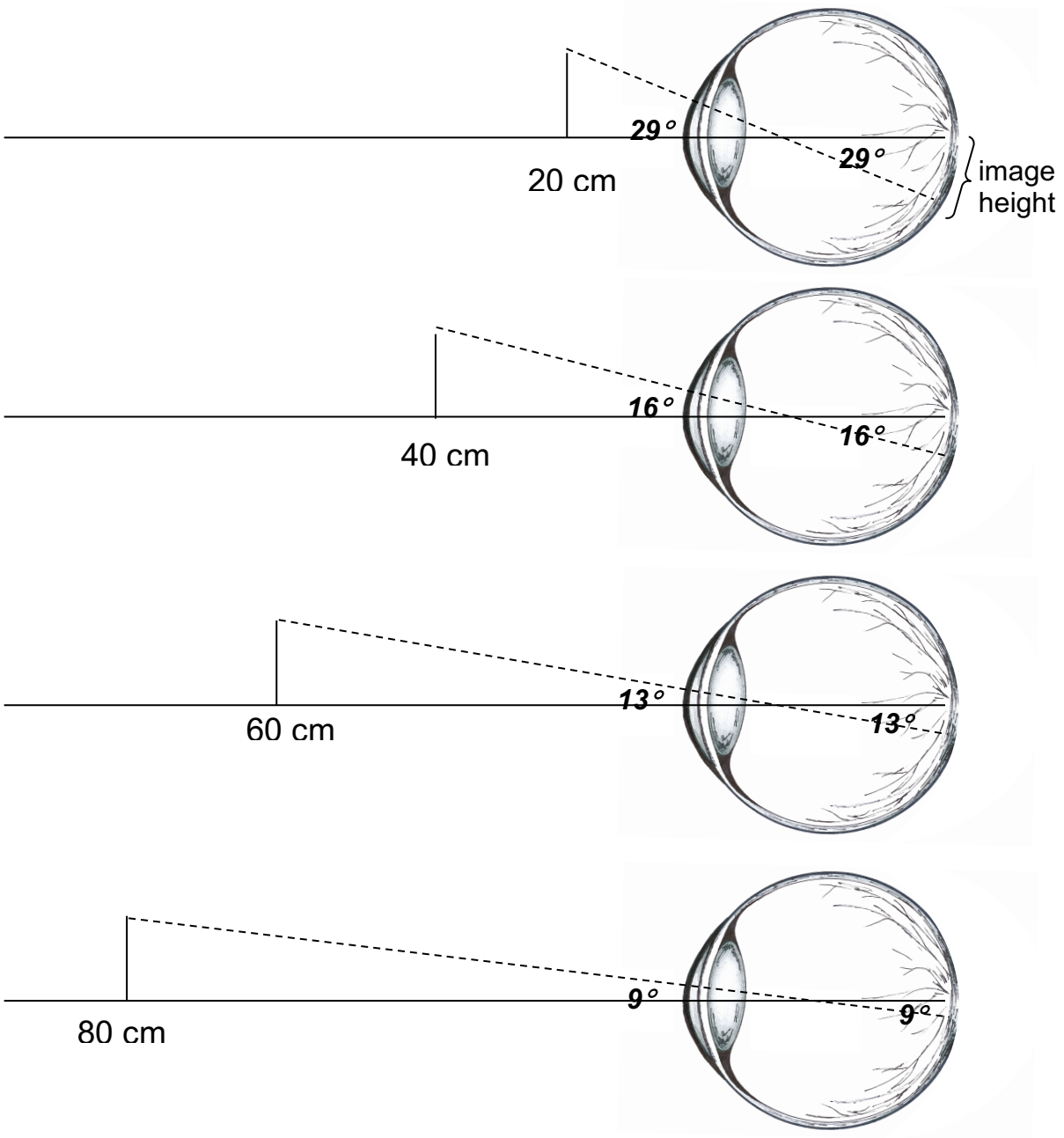
10. Look at Table A. What happened to the visual angle outside the eye as the centrifuge tube moved farther from the eye?

The visual angle outside the eye decreased as the centrifuge tube moved farther from the eye.

11. The diagrams below show the visual angle outside the eye, the visual angle inside the eye and the size of the image of the centrifuge tube on the retina for four of the distances you tested. Look for a pattern about the visual angles inside and outside the eye and the height of the image on the retina.



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12. Think about the results from your experiments in this Investigation and in Investigation One. Complete the sentences below.

Tool: **Rules**

a. As the visual angle outside the eye becomes smaller, the visual angle inside the eye becomes ***smaller***.

b. As the visual angle inside the eye becomes smaller, the height of the image on the retina becomes ***shorter***.

c. The farther an object is from the eye, the ***smaller*** the visual angle outside and inside the eye, and the ***shorter*** the height of the image on the retina.

d. The farther an object is from the eye, the smaller the visual angle outside and inside the eye and the ***narrower*** the width of the image on the retina.

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