

Seeing is Believing

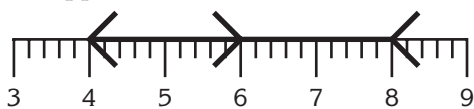
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Optical illusions have been popular for hundreds of years and are a source of fascination for many. These illusions can take many forms, from making you see things that aren't really there, to seeing multiple things in a single image. They have been developed and studied by psychologists and used by artists as far back as the 18th century. Perhaps the best-known artist to incorporate optical illusions into his work was M.C. Escher. Many of his most famous lithographs, such as "Waterfall" and "Ascending and Descending," use impossible figures as their basis.

In this activity, students will have the opportunity to explore four optical illusions in a way that is very different than how they are normally presented. The four illusions used here are all variations on the same theme: length distortion. These puzzles are usually posed as questions in which a figure is shown and you are asked which of two distances in the figure is longer. For example, in the figure shown below, which line segment is longer—the one on the left between the outward-pointing "Vs," or the one on the right between the inward-pointing "Vs"?



In fact, both line segments are equal as can be seen when the figure is placed on a ruler. Even on the ruler, however, the illusion persists, and the first half of the line appears to be shorter than the second half.



This illusion is accompanied by three others to form the basis of this *Puzzle Corner* activity. However, instead of merely giving students a page with the illusions printed in final form, they are presented as puzzles for students to "solve." Each

illusion is printed in two separate parts—the base puzzle and a corresponding sliding strip. These strips are woven into the base puzzles in such a way that they can be moved in and out, adjusting the distance between the various elements of the images. For two of the illusions, the challenge is to arrange the sliding strip so that the distance between three dots is equal. One illusion challenges students to place a dot at the center of a line, and the fourth illusion asks students to make two lines the same length.

Because these are *optical* illusions, students should not be allowed to use any kind of measurement when solving them. The point is not to get the "right answer." Rather, students should be allowed to see how much their perceptions are affected by things such as the direction of a line segment. If they "cheat" by measuring, folding their papers in half, or aligning them to some standard, the purpose of the activity is not achieved.

There are three student pages and one solution page (for the teacher) included with this activity. The first student page has the four base puzzles printed on it. Each student will need one copy of this page. The second page has two sets of the sliding strips; pairs of students can share one page. These first two pages need to be copied onto card stock (or laminated). Each of the puzzle bases and strips needs to be cut out. The dashed lines on the pieces indicate places where slits need to be made in the puzzles. It is best if this can be done without folding the puzzles. If possible, have an adult use a utility knife or the edge of a sharp pair of scissors to get a straight slit without folding.

The third student page gives questions for students to answer once they have tried each of the

puzzles. The page of solutions should be copied onto a transparency and cut out ahead of time. Once students have arranged the pieces of a puzzle the way they want, they should be allowed to check their answers by laying the transparency for that puzzle over the top to see how close they were.

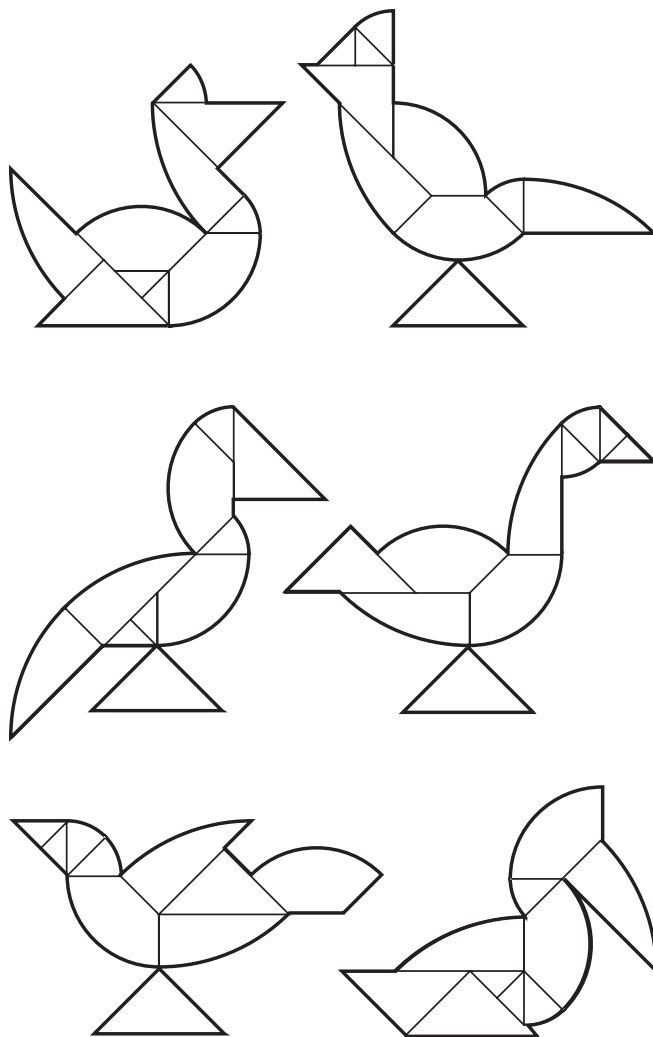
You are strongly encouraged to try these puzzles yourself before looking at the solutions. Even if you have seen these illusions before, you will likely have a difficult time getting all of them right. Doing the puzzles ahead of time allows you to anticipate management issues and gives you an appreciation for what your students will experience when they do this activity. It also gives students completed models to look at when assembling their own puzzles.

Be sure to spend time going over the questions on the final student page as a class. Because of the way our brains perceive visual input, all students should have had very similar experiences with the puzzles. It is important to discuss these similarities and to try and explore some of the possible reasons for them. Once some of those reasons are identified, students may even want to try and develop some illusions of their own.

We welcome your feedback on this activity, especially if you have any student work to share. I hope you and your students enjoy this optical adventure. We'll have another great *Puzzle Corner* activity next month.

Last Month's Puzzle

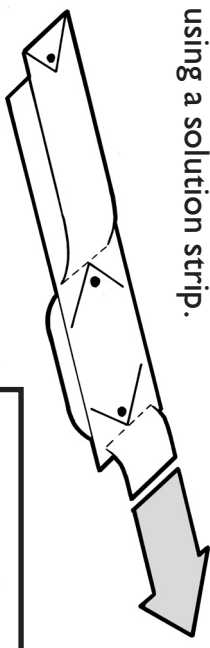
In *Hatching the Egg*, students were challenged to assemble 10 puzzle pieces to form various bird-shaped figures. The solutions are shown below.



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Cut out each of the puzzles on this page. Cut a slit along each of the dashed lines. (Be careful not to cut through the edges of the paper.) Cut out one set of the strips on the following page. Assemble each puzzle by weaving the strips through the slits on the puzzles (see the illustration below).

Follow the directions printed on each puzzle. Once you have placed the strips the way you want them, check your answer using a solution strip.



Puzzle One

Slide the dot so that it is in the center of the line.

Puzzle Two

Adjust the strip until the distance between all three circles is equal.

Puzzle Three

Adjust the strip until the distance between all three dots is equal.

Puzzle Four

Adjust the strip until the lines between each set of "Vs" are the same length.

SEEING IS BELIEVING

<p>Puzzle One</p>	<p>Puzzle One</p>
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Puzzle Three

Puzzle Three

Puzzle Two

Puzzle Two

Puzzle Four

Puzzle Four

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Answer the following questions after you have tried each puzzle.

1. For which of the puzzles was your answer closest to the correct answer? Why do you think this was?
2. For which of the puzzles was your answer furthest from the correct answer? Why do you think this was?
3. On *Puzzle One*, did you put the dot closer to the point of the arrow or the tail of the arrow? Why do you think you did this?
4. On *Puzzle Two*, did you put the third circle closer or further than it should have been? Why do you think this was the case?
5. On *Puzzle Three*, did you put the third dot closer than it should have been, or further than it should have been? Why do you think this was the case?
6. On *Puzzle Four*, did you make the second line longer or shorter than it should have been? Why do you think you did this?
7. Why is it so hard to get the right answer without measuring?
8. How do you think these illusions work?

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Solutions

Copy this page onto transparency film and cut out each puzzle solution. Allow students to check their answers against these solutions.



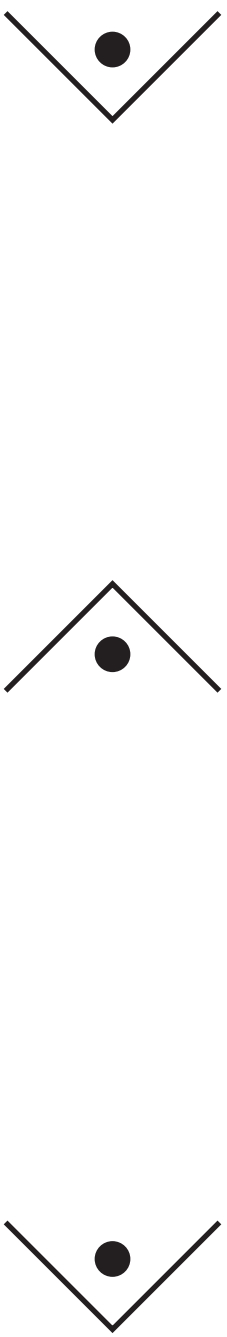
SOLUTION

Puzzle One



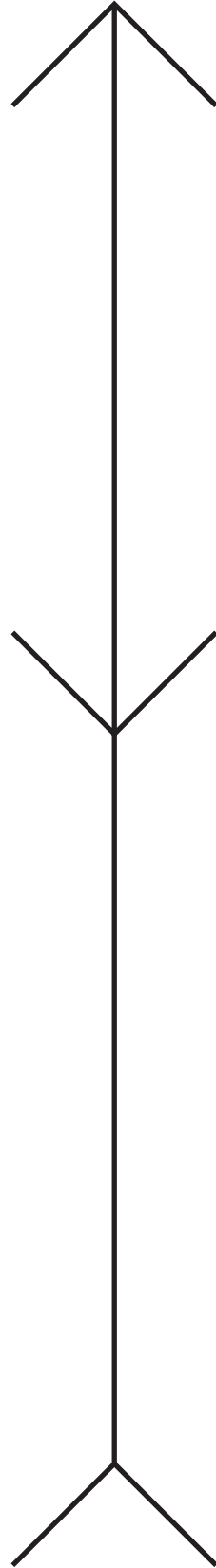
SOLUTION

Puzzle Two



SOLUTION

Puzzle Three



SOLUTION

Puzzle Four