UNIT ALIGNMENTS

GOALS, ARC OF LEARNING™, STANDARDS, NOW WHAT DO YOU KNOW?, AND EMERGING MATHEMATICAL IDEAS

Investigation 1: Enlarging and Reducing Shapes

Goals

Students will be working to develop elements of the following unit goals throughout Investigation 1.

Proportional Reasoning. Develop proportional reasoning strategies in the context of similar figures.

- Predict the ways that stretching or shrinking a figure will affect side lengths, angle measures, perimeters, and areas
- Contrast proportionality in the context of geometry (similarity) with numerical situations
- Stretch and shrink shapes to see that equivalent ratios are a multiplicative relationship between two quantities
- Informally solve proportions using scale factor or ratios to find missing side lengths on scaled (similar) figures
- Use similarity (scaling) to solve real-world problems

Similar Figures (Scale Drawings). Understand what it means for figures to be similar.

- Identify similar figures by comparing corresponding sides and angles
- Use scale factors and ratios to describe relationships between corresponding side lengths, perimeters, and areas in similar figures
- Recognize the role multiplication (ratios) plays in similarity relationships
- Recognize the relationship between scale factor and ratio in similar figures (scale drawings)
- Use informal methods, scale factors, and geometric tools, including algebraic rules that produce figures on a coordinate grid, to construct similar figures (scale drawings)

Arc of Learning™, Standards, Now What Do You Know?, and Emerging Mathematical Ideas

The detailed description of the Arc of Learning™ (AoL) can be found in *A Guide to Connected Mathematics*® 4 and the online portal. Unit standards correlations can be found at the end of this Teacher Edition or on the Lab-Aids website.

<table>
<tr><td colspan="2">Problem 1.1. Solving a Mystery with Proportional Reasoning
Arc of Learning™: Introduction, Analysis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
The Mystery Club advisor says that the picture is similar to the actual scene. What do you suppose the advisor means by similar? How is the photo similar to the actual scene.</td><td>Emerging Mathematical Ideas
Build off the common language of similar to informally introduce the idea of two figures being mathematically similar
Apply knowledge of ratios, and begin to recognize proportional relationships between quantities to estimate length of an enlarged figure.</td></tr>
<tr><td colspan="2">Problem 1.2. Designing a Poster Experiment Using a Rubber Band Stretcher
Arc of Learning™: Introduction, Exploration, Analysis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
For two similar figures, what characteristics and measures are the same? Different? Explain how you know.</td><td>Emerging Mathematical Ideas
Informally explore enlarging a geometric figure, and begin to notice which attributes change and which stay the same:
• Angles of the two figures appear to be the same.
• Side lengths of the enlarged figure are longer.
• Area of the enlarged figure is bigger.</td></tr>
<tr><td colspan="2">Problem 1.3. Scaling Up and Down with Percents
Arc of Learning™: Introduction, Exploration, Analysis
Standards: See your state alignment chart</td></tr>
<tr><td>Now What Do You Know?
For similar figures, what features (attributes) and measures stayed the same? What features (attributes) and measures changed? How does a multiplier play a role in these changes? .</td><td>Emerging Mathematical Ideas
Continue exploring enlargements and reduction of geometric figures, working to understand what attributes change and what attributes stay the same and by how much (the multiplier).
When exploring a set of geometric figures—original, an enlargement, and a reduction—begin to use and articulate relationships between attributes, such as the following:
• Corresponding angles of an enlargement or reduction of an original figure stay the same.
• Side lengths of an enlargement or reduction figure, as compared to the original figure, change in size by the multiplier used with the original
• Perimeter of an enlargement or reduction figure, as compared to the original figure, changes in size by the multiplier used with the original
• Area of an enlargement figure, as compared to the original figure changes but not by the multiplier used on the original figure; rather it grows by a greater factor than the multiplier</td></tr>
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	• Area of a reduced figure, as compared to the original figure, changes but not by the multiplier used on the original figure; rather it shrinks by a greater factor than the multiplier
Mathematical Reflection **Arc of Learning™: Exploration, Analysis** **Standards:** See your state alignment chart	
Mathematical Reflection What are the advantages and disadvantages of using different representations to show the relationship between two variables?	**Emerging Mathematical Ideas** Early exploration of proportional relationships between corresponding side length, perimeter, and area of similar figures. When exploring a set of geometric figures including an original and enlargement or a reduction, begin to use and articulate relationships between attributes, such as the following • Corresponding angles of an enlargement or reduction of an original figure stay the same. • Side lengths of an enlargement or reduction figure, as compared to the original figure, change in size by the multiplier used with the original. • Perimeter of an enlargement or reduction figure, as compared to the original figure, changes in size by the multiplier used with the original. • Area of an enlargement figure, as compared to the original figure, changes but not by the multiplier used on the original figure; rather it grows by a greater factor than the multiplier. • Area of a reduced figure, as compared to the original figure, changes but not by the multiplier used on the original figure; rather it shrinks by a factor greater than the multiplier.

Investigation 2: The Mug Wump Family: Similar Figures

Goals

Students will be working to develop elements of the following unit goals throughout Investigation 2.

Proportional Reasoning. Develop proportional reasoning strategies in the context of similar figures.

- Predict the ways that stretching or shrinking a figure will affect side lengths, angle measures, perimeters, and areas
- Contrast proportionality in the context of geometry (similarity) with numerical situations
- Stretch and shrink shapes to see that equivalent ratios are a multiplicative relationship between two quantities
- Informally solve proportions using scale factor or ratios to find missing side lengths on scaled (similar) figures
- Use similarity (scaling) to solve real-world problems

Similar Figures (Scale Drawings). Understand what it means for figures to be similar.

- Identify similar figures by comparing corresponding sides and angles

- Use scale factors and ratios to describe relationships between corresponding side lengths, perimeters, and areas in similar figures
- Recognize the role multiplication (ratios) plays in similarity relationships
- Recognize the relationship between scale factor and ratio in similar figures (scale drawings)
- Use informal methods, scale factors, and geometric tools, including algebraic rules that produce figures on a coordinate grid, to construct similar figures (scale drawings)

Arc of Learning™, Standards, Now What Do You Know?, and Emerging Mathematical Ideas

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<table>
<tr><td colspan="2">Problem 2.1. Drawing Wumps Experiment: Making Similar Figures
Arc of Learning™: Exploration, Analysis, Analysis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
How can you determine if an original figure and its image are similar by looking at the coordinate rule that produced the image? What features (attributes) stay the same for Mug and similar figures? What features change?</td><td>Emerging Mathematical Ideas
Explore enlarging geometric figures using coordinate grids and rules that produce both similar and non-similar figures. Expand understanding about which attributes change and which stay the same :
• Corresponding angles of two similar figures are the same measure while angles of non-similar figures may not be.
• Corresponding side lengths of the similar figure increase by the multiplier used to create a new rule</td></tr>
<tr><td colspan="2">Problem 2.2. Hats Off to the Wumps: Changing a Figure's Size and Location
Arc of Learning™: Analysis, Analysis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
If the coordinate rule creates a similar figure, how can you use the rule to predict the side lengths of the image? The location of the image on the coordinate grid?</td><td>Emerging Mathematical Ideas
Continue to explore enlarging, shrinking, and moving geometric figures using coordinate grids and rules that produce both similar and non-similar figures, including multipliers that are rational numbers. Expand understanding of which attributes change and which stay the same:
• Corresponding angles of two similar figures are the same measure while angles of non-similar figures may not be.
• Corresponding side lengths of the similar figure increase or decrease by the multiplier used to create a new rule.
• Adding or subtracting numbers to a rule results in a figure moving on a grid but not in changing the shape or size of the new figure</td></tr>
<tr><td colspan="2">Problem 2.3. Mouthing Off and Nosing Around: Scale Factors
Arc of Learning™: Analysis, Analysis
Standards: See your state alignment chart.</td></tr>
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Now What Do You Know? How can you determine the scale factor between two similar shapes?	**Emerging Mathematical Ideas** Introduce the term *scale factor*, and connect it to *multiplier* to describe the relationship between corresponding side lengths of similar figures Use knowledge of scale drawings/similar figures to determine if any two rectangles or two triangles are similar. Identify the scale factor of any two similar figures. Represent the relationship between corresponding sides of similar figures with a ratio
Mathematical Reflection **Arc of Learning™: Analysis, Analysis** **Standards:** See your state alignment chart	
Mathematical Reflection What do you now know about similar figures? What do you know about proportional reasoning?	**Emerging Mathematical Ideas** With similar figures, understand which attributes change and which stay the same • Corresponding angles of two similar figures are the same measure while angles of non-similar figures may not be. • Corresponding side lengths of similar figures increase or decrease by the scale factor used to create an image. • Perimeter of a new similar figure, as compared to the original figure, changes in size by the scale factor between the original and the new image Understand the relationship between corresponding sides of similar figures with a ratio

Investigation 3: Scaling Perimeter and Area

Goals

Students will be working to develop elements of the following unit goals throughout Investigation 3.

Proportional Reasoning. Develop proportional reasoning strategies in the context of similar figures.

- Predict the ways that stretching or shrinking a figure will affect side lengths, angle measures, perimeters, and areas
- Contrast proportionality in the context of geometry (similarity) with numerical situations
- Stretch and shrink shapes to see that equivalent ratios are a multiplicative relationship between two quantities
- Informally solve proportions using scale factor or ratios to find missing side lengths on scaled (similar) figures
- Use similarity (scaling) to solve real-world problems

Similar Figures (Scale Drawings). Understand what it means for figures to be similar.

- Identify similar figures by comparing corresponding sides and angles
- Use scale factors and ratios to describe relationships between corresponding side lengths, perimeters, and areas in similar figures

- Recognize the role multiplication (ratios) plays in similarity relationships
- Recognize the relationship between scale factor and ratio in similar figures (scale drawings)
- Use informal methods, scale factors, and geometric tools, including algebraic rules that produce figures on a coordinate grid, to construct similar figures (scale drawings)

Arc of Learning™, Standards, Now What Do You Know?, and Emerging Mathematical Ideas

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<table>
<tr><td colspan="2">Problem 3.1. Using Proportional Reasoning to Rep-tile: The Area Connection
Arc of Learning™: Analysis, Synthesis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
How do rep-tiles show the relationship between the scale factor and the perimeter and area of similar shapes?</td><td>Emerging Mathematical Ideas
Explore enlarging a geometric figure using “rep-tiling.” Expand understanding of similar figures and which attributes change and which stay the same:
• Corresponding angles of two similar figures are the same measure while angles of non-similar figures may not be.
• Corresponding side lengths of the similar figure increase by the multiplier used to create a new rule
• Perimeter of the rep-tile (similar) figure increases by the scale factor.
• Area of the rep-tile (similar) figure increases by the scale factor squared</td></tr>
<tr><td colspan="2">Problem 3.2. Designing Under Constraints: Scale Factors and Similar Shapes (Scale Drawings)
Arc of Learning™: Analysis, Synthesis, Synthesis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
How can you use scale factors to draw similar figures (scale drawings)?
How can you use scale factors to find missing information about angle measures? Side lengths? Area? Perimeter?</td><td>Emerging Mathematical Ideas
• Continue to explore enlarging and shrinking rectangles and triangles and exploring how the scale factor impacts side lengths, perimeter, and area of new scale drawings but not the measures of the angles:Corresponding angles of two similar figures are the same measure while angles:
• Corresponding side lengths and perimeter of the similar figure increase or decrease by the scale factor (multiplier).
• Area of similar figures increases or decreases by the scale factor squared (multiplier squared).
Expand understanding of how attributes of two similar figures are affected by the scale factor:
• Use the understanding to find lengths of corresponding side lengths that have missing measures.
• Use the understanding to find angle measures of corresponding angles that have missing measures</td></tr>
<tr><td colspan="2">Problem 3.3. Out of Reach: Finding Lengths with Similar Triangles
Arc of Learning™: Synthesis, Synthesis
Standards: See your state alignment chart.</td></tr>
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Now What Do You Know?	**Emerging Mathematical Ideas**
How can you use similar triangles to find a distance that is difficult to measure?	Introduce the term nested *triangles*, and broaden understanding of similar triangles. Use knowledge of similar figures/scale drawings, and apply it to nested triangles to solve real-world distance problems that are difficult to physically measure
Mathematical Reflection **Arc of Learning™: Synthesis, Synthesis** **Standards:** See your state alignment chart	
Mathematical Reflection	**Emerging Mathematical Ideas**
How can you use similar triangles to find a distance that is difficult to measure?	Continue exploration of proportional relationships between corresponding side lengths and perimeters of similar figures. With similar figures, understand which attributes change and which stay the same: • Corresponding angles of two similar figures are the same measure while angles of non-similar figures may not be. • Corresponding side lengths and perimeter of the similar figure increase or decrease by the scale factor (multiplier). • Area of similar figures increases or decreases by the scale factor squared (multiplier squared).

Investigation 4: Similar Figures and Ratios

Goals

Students will be working to develop elements of the following unit goals throughout Investigation 4.

Proportional Reasoning. Develop proportional reasoning strategies in the context of similar figures.

- Predict the ways that stretching or shrinking a figure will affect side lengths, angle measures, perimeters, and areas
- Contrast proportionality in the context of geometry (similarity) with numerical situations
- Stretch and shrink shapes to see that equivalent ratios are a multiplicative relationship between two quantities
- Informally solve proportions using scale factor or ratios to find missing side lengths on scaled (similar) figures
- Use similarity (scaling) to solve real-world problems

Similar Figures (Scale Drawings). Understand what it means for figures to be similar.

- Identify similar figures by comparing corresponding sides and angles
- Use scale factors and ratios to describe relationships between corresponding side
- lengths, perimeters, and areas in similar figures
- Recognize the role multiplication (ratios) plays in similarity relationships

- Recognize the relationship between scale factor and ratio in similar figures (scale drawings)
- Use informal methods, scale factors, and geometric tools, including algebraic rules that produce figures on a coordinate grid, to construct similar figures (scale drawings)

Arc of Learning™, Standards, Now What Do You Know?, and Emerging Mathematical Ideas

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<table>
<tr><td colspan="2">Problem 4.1. Equivalent Ratios Within Similar Figures
Arc of Learning™: Analysis, Synthesis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
What information do the ratios of adjacent side lengths within two similar figures provide about similar figures? How are these ratios helpful in solving problems?</td><td>Emerging Mathematical Ideas
Introduce the idea that ratios can be represented as fractions, extending their use from just comparison statements.
Explore the relationship between ratios of corresponding adjacent side lengths within two similar figures. Build off understanding of scale factor between similar figures to begin to understand why these ratios are equal.</td></tr>
<tr><td colspan="2">Problem 4.2. The Shadow and Mirror Experiments: Finding Heights
Arc of Learning™: Synthesis, Synthesis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
If two figures are similar, how can you use information about the figures to find unknown lengths, perimeters, areas, or angle measures?</td><td>Emerging Mathematical Ideas
Explore the use of similarity to solve real-world problems. Use understanding of similar figures, including scale factors and ratios, to find a distance that is difficult to measure
Understand that ratios of corresponding adjacent side lengths within two similar figures are equal.
• Use scale factor and/or ratio relationships between corresponding side lengths to determine if two figures are similar.
• Use understanding of scale factor and/or ratios of adjacent sides to find missing lengths, perimeter, and area</td></tr>
<tr><td colspan="2">Problem 4.3. More Imposters: Pulling It All Together
Arc of Learning™: Synthesis, Synthesis
Standards: See your state alignment chart.</td></tr>
<tr><td>Now What Do You Know?
What are strategies for identifying if a shape has been scaled to create similar figures or if the scaled figures are imposters?</td><td>Emerging Mathematical Ideas
Continue using proportional relationships to determine scaled figures.
Compare and measure geometric figures that are both similar and non-similar figures.</td></tr>
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Mathematical Reflection **Arc of Learning™: Synthesis, Synthesis** **Standards:** See your state alignment chart	
Mathematical Reflection What do you now know about similar figures? What do you know about proportional reasoning?	**Emerging Mathematical Ideas** Continue exploration of proportional relationships between corresponding side lengths and perimeter of similar figures. With similar figures, understand and be able to articulate which attributes change and which stay the same: • Corresponding angles of two similar figures are the same measure while angles of non-similar figures may not be. • Corresponding side lengths and perimeter of the similar figure increase or decrease by the scale factor (multiplier). • Area of similar figures increases or decreases by the scale factor squared (multiplier squared). • Ratios of corresponding adjacent side lengths within two similar figures are equal