The learner will understand and use properties and relationships in geometry.

Notes and textbook references

3

3.01 Represent problem situations with geometric models.

A. **Grandpa's Buried Treasure** (Blackline Masters III - 1 and III - 2)
Materials needed: Rulers
Students follow the instructions left by Grandpa to find the spot where the treasure is buried. They will report the answer as a coordinate from the grid. Grandpa's clues to the treasure involve concepts such as midpoint, perpendicular bisector, parallel, proportion, and using the Cartesian coordinate plane.

Since early errors or inaccuracies can have a major impact on the ultimate solution, it is important to provide several "check points" along the way. You can use Abe's mailbox (-5, 2) and Sally's gate (4, -5) as "check points". You can also identify the quadrant(s) where certain locations can be found. This will avoid discouragement as the hunt progresses. The ultimate treasure will be found at or near (-5, -1.5).

You can give half of the class metric rulers and give the rest of the class customary rulers. A discussion of which was easier to use might ensue at the end.

B. **Ladders and Saws** (Blackline Masters III - 3 through III - 5)
Materials needed: A sheet of drawing paper for each student, rulers, coloring implements (crayons, colored pencils, or markers), scissors
This powerful tool for having students explore concepts related to parallel lines and polygons was developed by Dina van Hiele-Geldof in conjunction with her doctoral dissertation. "Ladders and Saws" provides a nice bridge between concrete manipulative materials and formal deduction. This activity was reprinted with permission from *Woodrow Wilson Foundation – 1991 Mathematics Institute*.

Notes and textbook references

C. Area Challenge (Blackline Master III - 6)
This activity gives your students a chance to review area of circles while they find the area of irregular shapes. Students should be encouraged to look for ways to add and subtract areas of common geometric figures to find areas of the shaded shapes.

D. Cooperative Problem Solving Cards (Blackline Masters III - 7 through III - 11)
Students work in groups to solve these problems. For each problem, the cards are distributed among the students so that no one student has all the problem clues. A student may share the information on his card, but he must keep possession of the card. Working in groups to solve problems, gives students a chance to observe the thought processes of other students and also provides an opportunity for students to use their vocabulary in a meaningful way.

E. Geometry – Ancient and Modern (Blackline Master III - 12)
Materials needed: Compass, straight edge
Geometry is all around us. Have students construct these ancient and modern symbols with a compass and straight edge. Afterwards, you can have students find additional symbols and construct a logo of their own. Helpful internet resources may be found at the following websites:
http://www.earthmeasure.com/Designs/index.html
http://www.pbs.org/teachersource/mathline/concepts/designandmath/activity2.shtm

F. Cook's Trick Extension (Blackline Master III - 13)
This activity can be used as an extension. Darryl's restaurant serves dishes on round plates and oval plates. Your students can use the formula for the area of an ellipse to help compare the serving areas of these two dishes. You may also want to explore plates of other shapes, such as rectangles and irregular shapes. You could even bring in plates of different shapes, and have students measure them and compare their areas.

G. Symmetry Challenges Extension (Blackline Master III - 14)
Students use given quilt blocks to create a quilt pattern with four lines of symmetry. This extension is a great way to tie history and geometric concepts such as symmetry, reflection, and rotation. A wonderful website to visit is Planet Patchwork (**http://planetpatchwork.com**). This website (**http:/planetpatchwork.com/tesselat.htm**) contains information about tessellating quilts as well as mystery quilts that are completed as a mystery is solved. Many quilt block patterns can be found at the QuiltBlocks page (**http://ttsw.com/QuiltBlocksPage.html**).

Notes and textbook references

Notes and textbook references

3.02 Apply geometric properties and relationships, including the Pythagorean theorem, to solve problems.

A. **Shoebox Geometry**

Materials needed: Various size boxes, tape measures
Collect shoe boxes and other boxes of various sizes. Use the Pythagorean Theorem to find the longest object that will fit into a shoebox or other box. After you have done this, find the longest object that could fit through the door of your classroom or the door to the school.

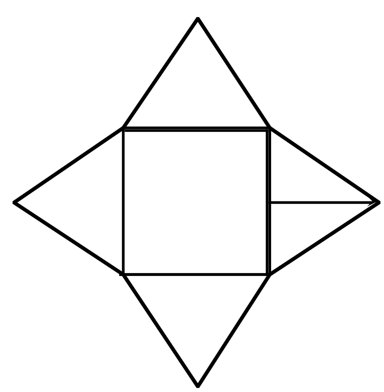
B. **Television Screens** (Blackline Master III - 15)

The size of a television screen is the measurement of the diagonal. Several different widths and lengths could produce the same diagonal measurement. Explore possibilities of TV screen sizes. Discuss which dimensions would be practical for a television screen and which dimensions would not. This would be a good activity for a spreadsheet.

C. **Pyramid Power**

Materials needed: Large drawing paper, rulers or metric sticks, protractors, scissors, tape
Earlier in this century, some people believed that the shape of the Egyptian pyramids had the ability to focus energy. It was believed that this energy could be used to mummify animals, sharpen razor blades, improve the ability of seeds to sprout, preserve food, and increase the human ability for thought.

Have students build pyramids that are proportional to the Great Pyramid of Cheops. The ratio of the height of the Pyramid to the width of the base is approximately 7:11. Have students make a pattern for a pyramid by drawing a square with an isosceles triangle attached to each side. If the square measures 6 cm on a side, what would the height of the finished pyramid be? What should the altitude and base length be of each isosceles triangle so that the pyramid will have the appropriate height? The following website gives information about the Great Pyramid of Cheops:
http://interoz.com/egypt/cheops.htm

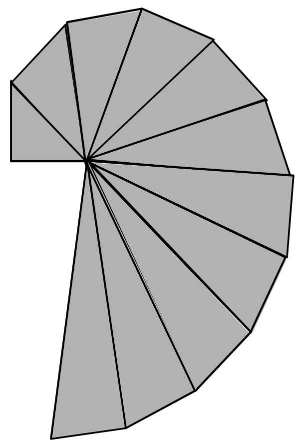


Notes and textbook references

D. Pythagorean Design

Materials needed: Ruler

Begin with an isosceles right triangle that has legs of length 1. Verify that the hypotenuse of this triangle is $\sqrt{2}$ Now use the hypotenuse as a leg for a new triangle. The other leg of this triangle should have a length of 1. Verify that the hypotenuse is $\sqrt{3}$. Continue making more triangles; each time let the previous hypotenuse be a leg, and add a leg with length 1. You will be constructing the square roots of the integers. The design makes a nice spiral.



E. Pythagorean Theorem with Tiles (Blackline Masters III - 16 and III - 17)

Materials needed: 1″ square tiles (at least 50 per group), centimeter grid paper (Blackline Master III- 16), scissors, handout with a 3″, 4″, and 5″ triangle on it

Create a handout with a 3″, 4″, and 5″ triangle on it. Have students work in groups of four. Students should build squares with their tiles along the legs of the triangle (a^2 and b^2). Challenge students to find how many tiles it will take to construct a third square with the hypotenuse of the triangle as one side (c^2). Repeat this activity with triangles of other sizes. If the number of tiles needed is a problem, have students draw the triangles and squares on centimeter grid paper. As a class, record the results in a table and look for a pattern. Encourage students to look for a pattern between the relationship of the square of the hypotenuse and the squares of the other two legs.

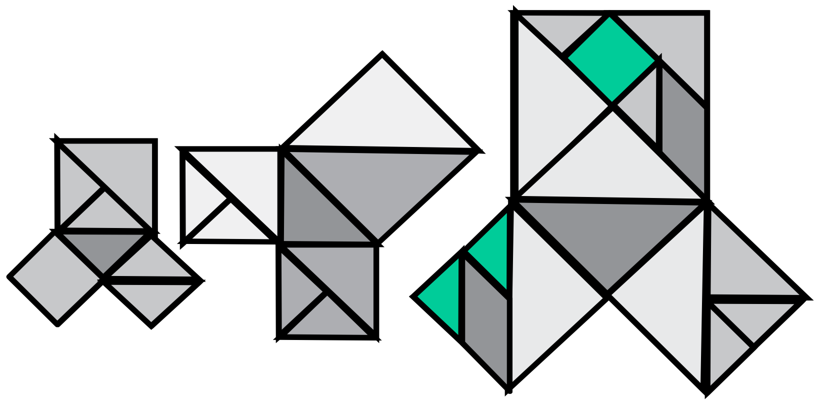
Note: You may want to have students construct right triangles and their square sides on Geoboards or centimeter grid paper before you do this activity. Students may also need to have prior knowledge of calculating the area of squares. Some of the squares will have side lengths that are irrational; their areas are usually more challenging for students to find.

Notes and textbook references

F. **Pythagoras with Tangram Pieces** (Blackline Master III - 18)

Materials needed: Tangram pieces

If you do not have sets of Tangrams, you can have students create their own using Blackline Master III - 18. Students work together in groups, and each group will need several sets of Tangram pieces. Have groups use the Tangram pieces to form a triangle with a square on the legs and hypotenuse of the right triangle. They will take the pieces of the two smaller squares to arrange them on the large square connected to the hypotenuse. This can be done with each of the right triangles; however, students may need more copies of some of the smaller pieces to accomplish this. In each case it can be shown that the square on the hypotenuse has the same area as the total of the squares on the legs.



G. **The Amazing Pythagoras** (Blackline Masters III - 19 and III - 20)

Materials needed: Centimeter ruler

Students develop the concept of the Pythagorean Theorem by identifying right triangles, measuring sides, and looking for patterns. After carefully measuring the sides of each triangle, students will record the data in a table. Students will square each side length, compare, and draw conclusions about their observations.

H. Cut and Tape Proof of the Pythagorean Theorem

(Blackline Master III - 21)

Materials needed: Crayons or colored pencils, scissors, glue

Students should color the three squares different colors. Cut out pieces 1 through 5. Fit these pieces on the square with the side length *c* to illustrate $a^2 + b^2 = c^2$. The following website has an applet that gives a visual demonstration of a similar proof: http://standards.nctm.org/document/eexamples/chap6/6.5/index.htm#applet.

I. Pythagorean Construction – A (Blackline Master III - 22)

Materials needed: Centimeter grid paper, scissors

Students cut out pieces of rectangles to illustrate the Pythagorean Theorem.

J. Pythagorean Theorem Flip Book (Blackline Masters III - 23 through III - 26)

Materials needed: Scissors, stapler

Have students cut out and staple the pages of the flip book. When they flip it, they will see an animation that demonstrates the Pythagorean Theorem.

K. Group Explorations

Materials: Rulers, protractors, white paper, patty paper (optional)

Have students work in groups to draw several right triangles. They should measure the sides and verify that they satisfy the Pythagorean Theorem.

L. Real World Pythagoras (Blackline Masters III - 27 and III - 28)

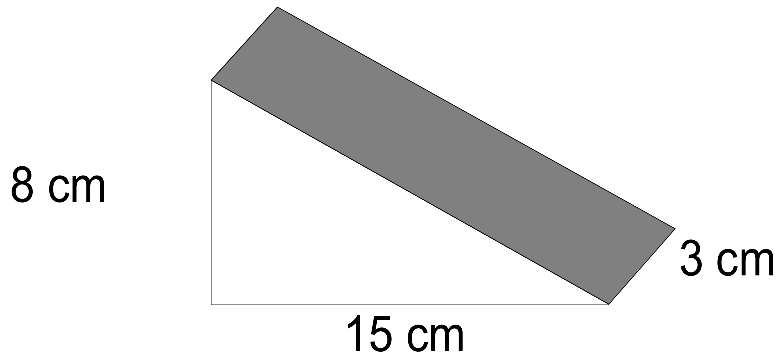
Use the problems on the handouts for applications of the Pythagorean Theorem.

Notes and textbook references

Notes and textbook references

M. **The Pythagorean Theorem and Area**

Have students use the diagram below to find the area of the shaded face. You may want to extend this task to Geoblocks and ask for the area of a colored or labeled face.



N. **Taxi Cab Geometry and City Maps** (Blackline Master III - 29)

Use the Taxi Cab Geometry Sheet or have students draw a map of the streets in their town. Make streets intersect at right angles. Calculate the "direct distance" from the beginning to the end of a taxi's trip.

Note: The taxi's travel route should form a right angle, and the "direct distance" is the hypotenuse.

O. Geometric Relationship among Similar Figures

Notes and textbook references

Materials needed: Computers, internet access

Divide students into small groups. Give each group a set of geometric figures that are similar (triangles, trapezoids, rectangles, parallelograms, etc.). For example, give one group a set of similar triangles, another group a set of similar trapezoids, and so forth and so on. Have students measure the angles and lengths of the sides of the figures. Have them find the area and perimeter of the figures. Ask students to look for relationships among the measures of the lengths of the sides and angle measurements of the similar figures. Have students compare the perimeters and areas of the figures. Next, have students explore the relationship between length, perimeter, area, and volume of similar figures. You can do this by using the interactive applets at the websites listed below:

http://standards.nctm.org/document/eexamples/chap6/6.3/index.htm#applet
http://standards.nctm.org/document/eexamples/chap6/6.3/part2.htm

Notes and textbook references

3.03 Identify, predict, and describe dilations in the coordinate plane.

A. House Hunting (Blackline Masters III- 30 and III - 31)

Materials needed: graphics calculator

NOTE: This activity can also be done manually but is more engaging when using a graphics calculator.

Activity:

Make an overhead transparency of the "house" on the coordinate grid and display for the students.

Locate the coordinates of the "house" that is shown on the coordinate plane on the blackline master. Enter the x-coordinates in L1 and the corresponding y-coordinates in L2 in the lists (STAT menu) on the graphics calculator. Be sure to keep them in an order so that the graphics calculator can "draw" them and repeat the beginning coordinate at the end of the list so the "drawing" will be connected. Set up a connected scatterplot (second icon) on the STAT PLOT and graph the plot on a standard window setting.

Notes on the blackline master will assist in the teacher in using the graphics calculator to make dilations.

Questions:

1. Compute the area of the houses (combination of rectangle and triangle) and show that the larger house is double the area of the smaller house. How do the perimeters relate?

2. Can you develop a procedure to make house three times the size of the first house and locate it in the Quadrant III? Use another STAT PLOT for this so you can see all three houses.

Extensions:

1. If you only multiplied the x-coordinates of the original house by 2 and not the y-coordinates, would the house be dilated? How would that house look on the coordinate plane? What effect would it have on the area and perimeter as compared with the first house? Can you determine how to make other houses, both thinner and wider?

2. How would you reflect the first house over the x-axis so it is up-side down in Quadrant IV? (This is similar to a reflection in a pond).

3. Use another figure (like a Christmas tree) to explore dilations, but also translations and reflections.

B. Coordinate Plane Dilations

Materials needed: Graph paper, patty paper (optional), rulers
Divide students into groups of four. Give the entire class the coordinates of a geometric figure, such as a pentagon or hexagon, which you have chosen ahead of time. Have each student graph this geometric figure on a coordinate plane. Give each member of the group a different scale factor, giving two students a scale factor less than one and the other two students scale factors that are greater than one. Have each student multiply the original coordinates by their scale factor and graph their new coordinates. Ask students to compare the corresponding angle measures and sides. Students may do this with rulers and protractors. They can also use patty paper to verify relationships by tracing the original figure onto a sheet of patty paper and overlaying it with the new figure. Have groups discuss any relationships that they notice, and then discuss group findings as a class.

C. Scale Factor

Materials needed: Computers, internet access
This interactive website (http://matti.usu.edu/nlvm/nav/frames_asid_295_g_3_t_3.html?open=activities) allows students to drag a slider that increases and decreases a scale factor to shrink or expand an image. When the scale factor is one, students are able to see that the figures overlap. When the scale factor is less than one, the applet demonstrates that the image shrinks, and when the scale factor is greater than one, students can visualize the expansion of the image.

D. Creating a Mural

Materials needed: Colored pencils, markers, or crayons, large drawing paper, large grid paper
Have students select some type of image, such as a cartoon, drawing, or logo. Students will enlarge their image by a scale factor of two or more. It may be helpful for students to place a coordinate grid over their original image first, and then draw the enlarged image on a large piece of grid paper. Students can then draw or trace the enlarged image onto a large sheet of drawing paper. Your class could also create a large mural on a wall in a similar fashion. This could be done as a joint project with an art teacher in your school. If you want students to do a reduction, you could give students a large picture of your school mascot or some other image and ask students to reduce the image using a scale factor of one half, or anything less than one.

Notes and textbook references

Notes and textbook references

E. Internet Applets and Dilations

Materials needed: computers, internet access

The internet provides a wide range of tools that can be used to stimulate student thinking about dilations. The following websites allow students to explore the relationship between scale factor and the area of an object through the use of interactive applets. Each of these sites allows students to change the scale factor, as students change the scale factor they can see the effect on the size of the object.

http://www.mathsnet.net/transform/enle1.html
http://www.mathsnet.net/dynamic/enlarge.html
http://www.mathsnet.net/dynamic/enlarge2.html
http://www.mathsnet.net/transform/enlindex.html