Applications

1. Which capital letters have reflection symmetry? For each one that does, describe all the lines of symmetry.

A B C D E F G H I J K L M N O P O R S T U V W X Y Z

Tell whether the design has reflection symmetry. If it does, sketch the design and draw all the lines of symmetry.

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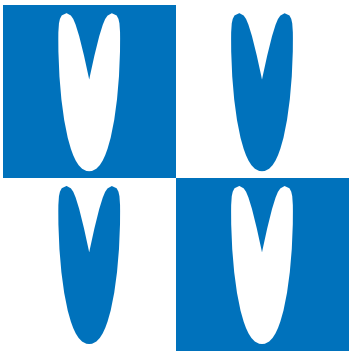
2.

3.

4.



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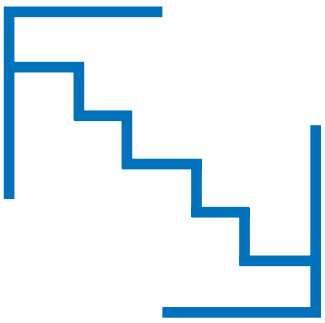


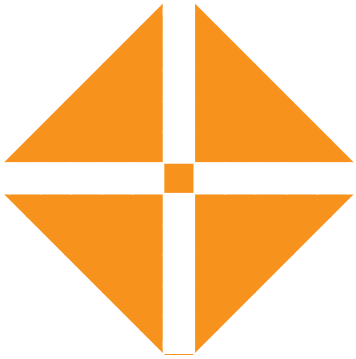
For Exercises 6–9, tell whether the design has reflection symmetry. If it does, sketch the design and draw all the lines of symmetry.

6.

7.

8.

9.



10. Which of the figures in Exercises 2–9 have rotation symmetry? For each one that does, find the angle of rotation and tell which multiples of this angle rotate the figure to a position in which it looks like the original.

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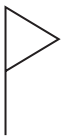
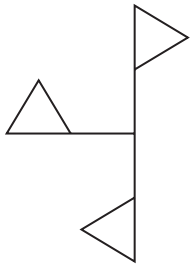
11. Which capital letters have rotation symmetry? For each one that does, give the angle of rotation.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

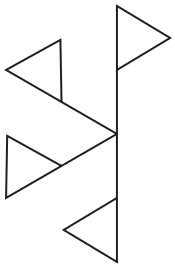
For Exercises 12–14, use the flag shape at the right as a basic design element. Complete a design with rotation symmetry and give the angle of rotation.



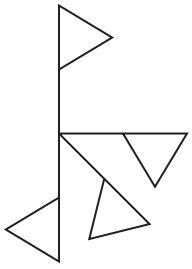
12.



13.

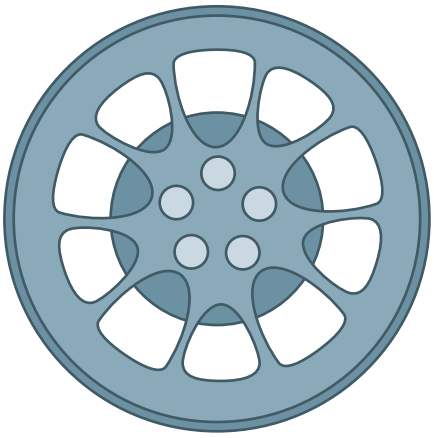


14.



15. **a.** Give the angle of rotation for the hubcap at the right.

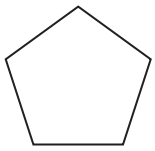
b. Copy the hubcap and draw the lines of symmetry.



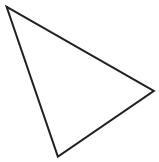
16. Draw a hubcap design that has rotation symmetry with a 120° angle of rotation and at least one line of symmetry.

17. **Multiple Choice** Which figure does not have rotation symmetry?

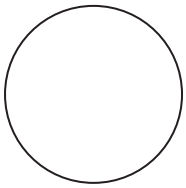
A.



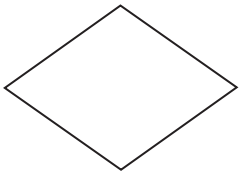
B.



C.

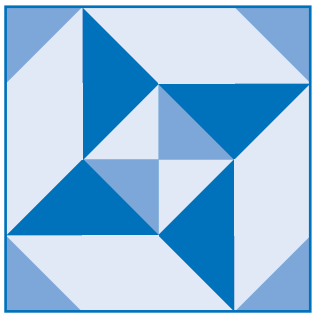


D.



Describe the reflection and rotation symmetries for each traditional quilt design.

18.



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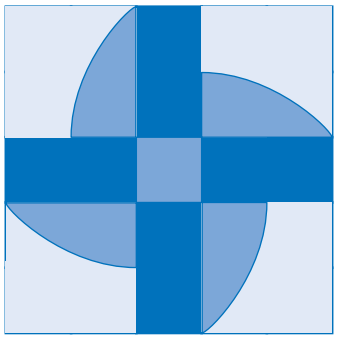
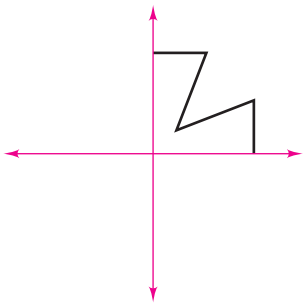
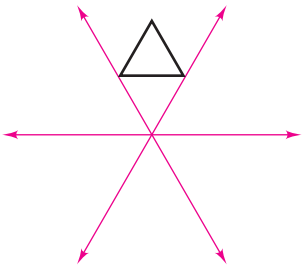


For Exercises 20–23, copy the drawing. Then, draw a design with the given lines as lines of symmetry.

20.

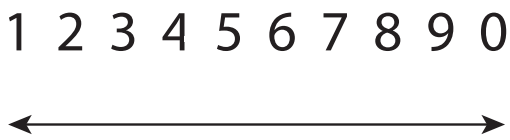


21.



22.

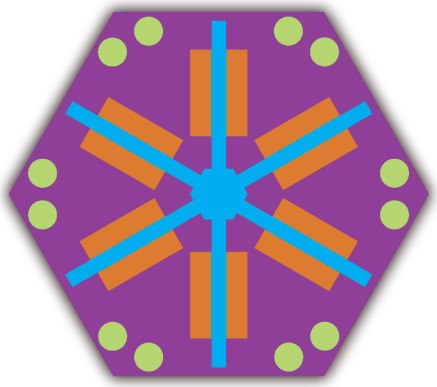
23.



For Exercises 24 and 25, describe the rotation and reflection symmetries for the design.

24.

25.



26. In parts (a) and (b), use a capital letter as the basic design element.

a. Sketch a strip pattern with reflection symmetry only.

b. Sketch a strip pattern with reflection symmetry and rotation symmetry.

27. **a.** Using the capital letter X as the basic design element, sketch part of a wallpaper pattern.

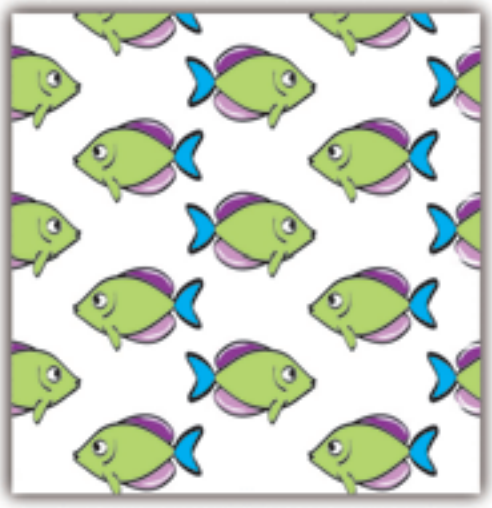
b. Show, with arrows, all the translations that slide the design onto itself.

c. Draw the lines of symmetry for your design.

d. Describe the rotation symmetries in your design.

For Exercises 28–30, identify the basic design element for the wallpaper design. Then, describe how this basic design element can be copied and translated to produce the pattern. Include diagrams with arrows and measures of distance.

28.



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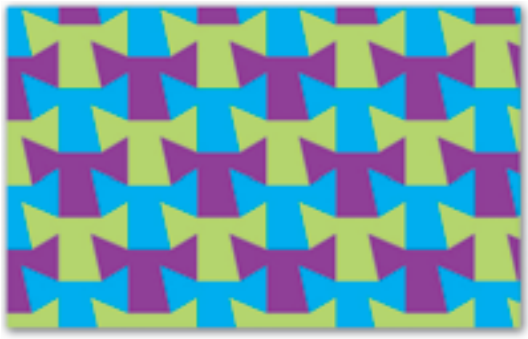


30.

Connections

Consider state names written in capital letters (for example, ALABAMA **or** MICHIGAN**).**

31. Find a state name that has reflection symmetry when written horizontally.

32. Find a state name that has reflection symmetry when written vertically.

33. Write a word or phrase that has

a. reflection symmetry when written horizontally

b. reflection symmetry when written vertically

Draw an example of each type of polygon. Draw all the lines of symmetry. If the polygon has rotation symmetry, identify the center and angle of rotation.

34. square

35. non-square rectangle

36. non-rectangular parallelogram

37. isosceles triangle

38. equilateral triangle

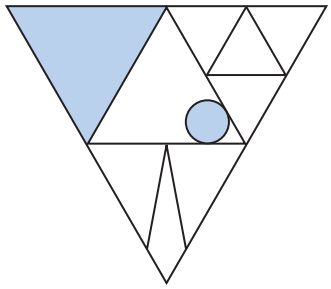
39. non-square rhombus

40. isosceles trapezoid

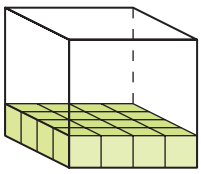
The designs in Exercises 41–45 are actually first names. Describe the symmetries in each name. Then, write the name in standard lettering.

Source: ScottKim.com

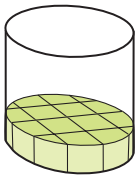
46. Copy the design below. Then use tracing paper to help you sketch a full kaleidoscope design from this basic design element.



47. Prisms and cylinders each have two congruent faces one of which is the base. The drawings show a prism and a cylinder that are 4 centimeters high. Each is filled with a layer of centimeter cubes. The cubes in the bottom layer of the cylinder include some parts of cubes to make an exact covering of the base of the cylinder.



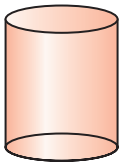
Rectangular Prism

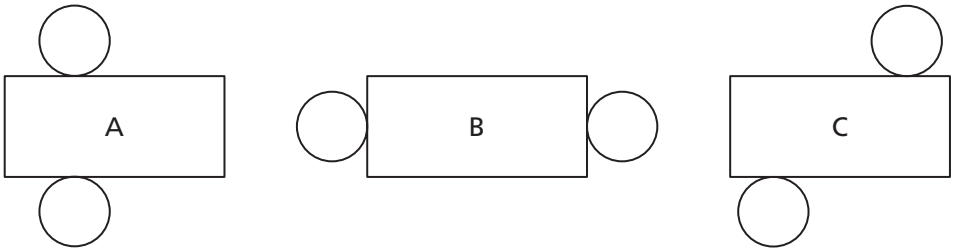


Cylinder

a. How many layers will it take to fill the prism?
b What is the volume of the prism?
c. What formula does this suggest for finding the volume of a prism?
d. How many layers will it take to fill the cylinder?
e. What is the volume of the cylinder?
f. What formula does this suggest for finding the volume of a cylinder?
g. How do the volumes of the prism and cylinder that are given compare?

48. At the right is a cylinder and below are three patterns that show the faces of that cylinder.





a. Which pattern is not a flat pattern for a cylinder?

b. Which patterns have reflection symmetry? Make sketches to show the lines of symmetry.

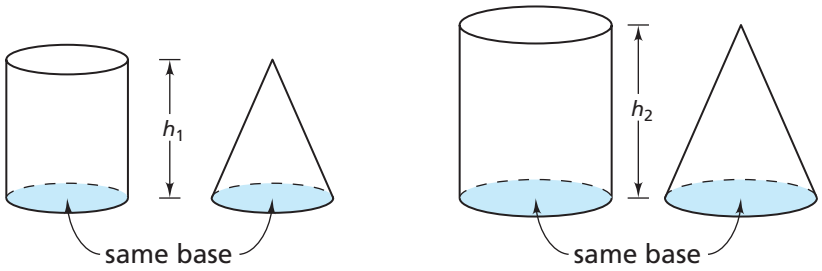
c. Which patterns have rotation symmetry? Make sketches to show the centers of rotation.

d. What measurements would you need to make to find the volume of a cylinder?

e. How do your measurements connect to the formula for finding the volume?

f. What is the volume of the cylinder if the base has a radius of 6 cm and the height is 15 cm?

49. Tyrone has been experimenting with cylinders and cones. He has made several paper cones and cylinders with the same height and base. He fills the cone with colored sand and pours it into the cylinder with the same base and height. To his surprise it always takes 3 cones of sand to exactly fill the cylinder.

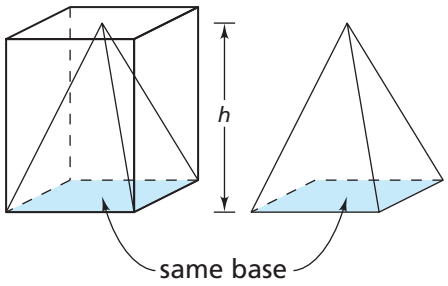


a. The height of a cylinder is 8 cm and its base has a radius of 3 cm. What is the volume of the cone with the same base and height?

b. What formula for the volume of a cone does Tyrone's experiments suggest?

c. Tyrone makes some prisms and pyramids that are related. Each pair has the same base and height. He conducts the same experiment and finds that it always takes 3 pyramids to fill the matching prism exactly. What formula does this suggest for the volume of a pyramid?

d. If the base of a square pyramid is 7 cm on each edge and its height is 12 cm, what is its volume?

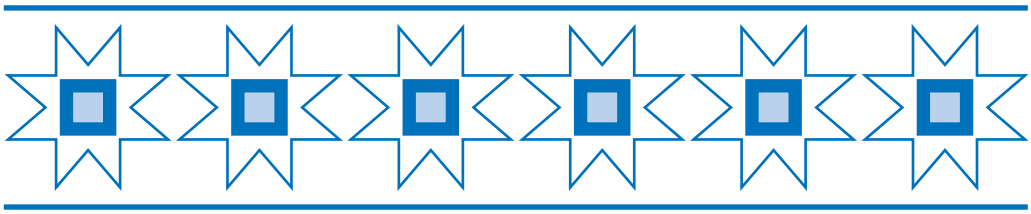


Connections

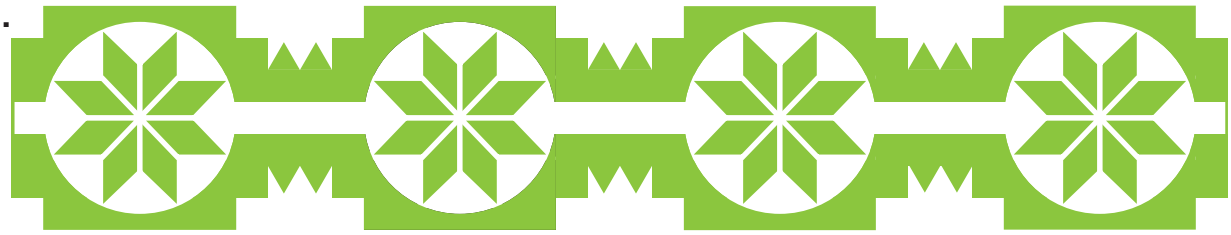
These strip patterns are found in crafts in traditional cultures around the world. For each pattern, identify the basic design element and describe the lines of symmetry and center and angle of rotation. (Assume each design continues without bound to the left and right.)

50.

51.



52.



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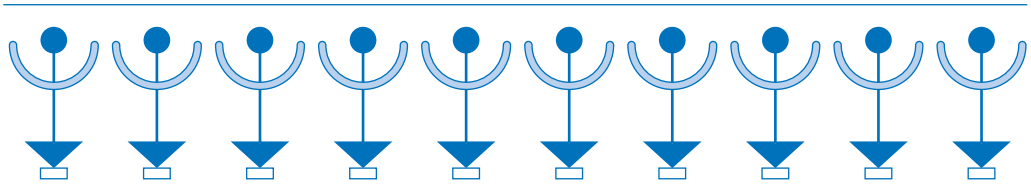
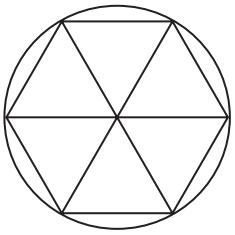


Extensions

54. A regular hexagon can be enclosed by a circle as shown in the following sketch.



a. Describe all the symmetries in the figure.

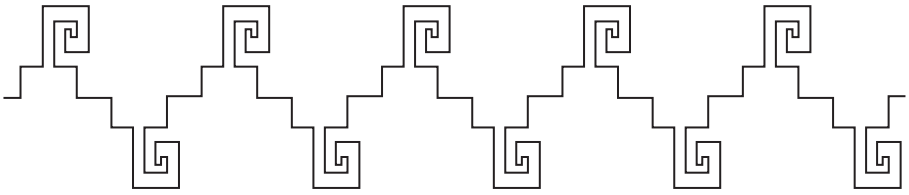
b. What are the angle measures of the triangles in the figure? Explain how you know.

c. Suppose you started with a circle with the center marked. How can you use the symmetries you observed in part (a) to construct

- a regular triangle?
- a regular hexagon?

d. How are your answers to parts (a), (b), and (c) related to the symmetries in any kaleidoscope pattern?

55. In this investigation, you studied designs with reflection, rotation, and translation symmetries. The design below is a bit different from those you have seen.



a. Trace a basic design element from which the rest of the pattern can be produced using only translations.

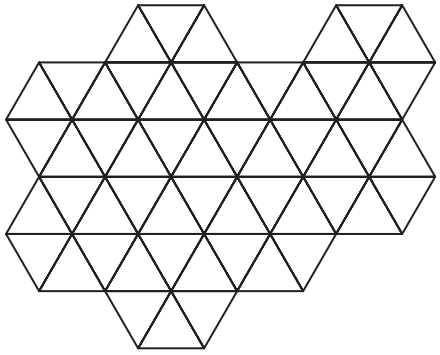
b. Trace a smaller basic design element from which the rest of the pattern can be produced by using a translation followed by a reflection. Indicate the line of reflection and the length and direction of the translation.

c. The movement required in part (b) to generate the pattern is called a *glide reflection*. What is the difference between a reflection and a glide reflection?

56. Using a capital letter as the basic design element, make a strip pattern using only glide reflections.

57. **a.** Make a sketch of the design below. Outline a basic design element that can be translated to produce the entire design.

b. Draw arrows to specify the distance and direction(s) you need to slide your basic element to make this design.



c. Can you translate a single triangle to make the design above? Explain.

Extensions