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Snowflake Geometry

An engaging wintertime activity exploring symmetry and geometry.

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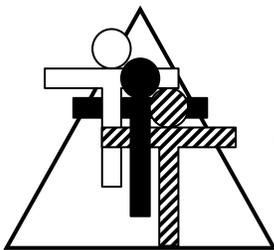
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References available upon request

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Snowflake Geometry

This seasonal project is a great motivator before or after Christmas vacation. It incorporates the concepts of lateral and rotational symmetry and makes a great art display too.

Required Materials:
- ☒ paper (thin paper is best)
- ☒ scissors

Optional Materials:
- ☐ construction paper
- ☐ glue
- ☐ spray paints

Procedure:

1. Give students scissors and sheets of thin 8½" by 11" paper. Cheap printer paper works well. Even newsprint can be used, but white paper is better.

2. Begin by showing the students how to fold the five-point snowflake. This is the easier of the two patterns. Model each fold in front of the class, and check their progress often.

3. Once they have reached the last step they will have a shape similar to the one on the right. They can cut away the shaded portion if they wish; it will not be used in the final snowflake.

4. They should then make cuts along edges AC and BC. These will form the design on the interior of the snowflake. Cuts made along edge AB will appear on the outer edge of the final snowflake. Let them experiment. Cutting off point C will form a pentagonal hole in the center of the snowflake. Cutting off point C at an angle will form a five-point star in the center.

5. As the students experiment with various cuts along the edges, they will develop the concepts of lateral symmetry. For example, hearts and Christmas trees can be formed as shown here. When the snowflakes are unfolded, rotational symmetry can be observed.
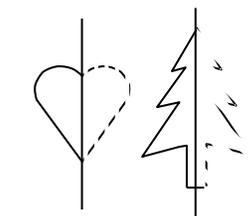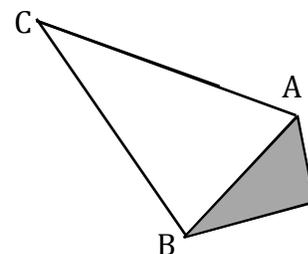
Lateral Symmetry
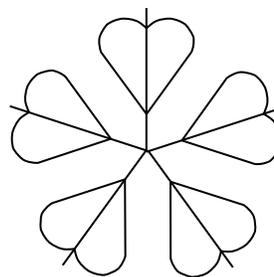
Rotational Symmetry

6. Using the six-point star pattern can create a more realistic snowflake. Although this is more difficult to fold and to cut, the students will be ready after practicing the five-point star.

7. Snowflakes can be displayed in many ways. White ones look great when glued on black or dark blue construction paper. These can be decorated with paint and glitter. Some students glue them onto holiday gift boxes for a unique handmade look. Consider using the "snow-in-a-can" that can be purchased in department stores. Lightly tack the snowflake onto a window using a glue stick, spray it with the canned snow, then peel off and discard the used snowflake for a wintry look.

8. Each snowflake creates both a "positive" and a "negative" image. Once a snowflake is cut out, it can be glued onto a contrasting color of paper.

9. The scrap can also be unfolded and used as a stencil. Place the stencil over paper and spray it with a contrasting color of paint. The gold and silver metallic colors look nice.

10. A student activity page is provided on the page following the written directions so students can take home instructions for the five-point and six-point star.

11. This activity allows students to learn crucial geometry vocabulary while they are engaged in an entertaining lesson. I use terms such as **midpoint**, **edge**, **vertex**, **bisect**, **median**, and **symmetry** as I give the instructions. By hearing these words while they see and perform the folds, they learn vocabulary in a natural way.

12. You may wish to challenge your students by asking them these questions:
    a. How can you form a perfect pentagon or hexagon?
    b. How should you cut it to make a star?
    c. How many vertices are on a hexagon? (6)
    d. How many vertices are on a six-pointed star? (12)
    e. How many edges are on a six-pointed star? (12)
    f. How many concave angles are on a six-pointed star? (6)
    g. Where should you cut to form a star in the center of the snowflake?

    h.   Can you double the number of points on the star?
    i.   Can you cut the template to make a snowman or a Christmas tree?

13. Allow students to experiment with their designs. They will tend to design more sophisticated snowflakes as they work. Give them time to "tour the snowflake factory" to admire the designs other students have made. I have found that an overhead projector provides a great way to display their designs so everyone can see them.

14. When made with white printer paper, the snowflakes make great decorations to tape onto a window in the classroom or in the student's home.

The Common Core Connection

This activity addresses these Common Core Math standards:

4th grade geometry:
3.   Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.

8th grade geometry:
1.   Verify experimentally the properties of rotations, reflections, and translations…

In addition, because of the hands-on nature of this engaging activity, students in other grades will benefit from participation as they form the foundation for what they will encounter later in more formal studies of symmetry, reflections, and transformations.

As your students work and experiment they will begin to visualize how cuts made in the template will form designs on the unfolded snowflake. This development of spatial visualization is crucial to success in formal geometry.

They will also see how the central angle of the snowflake template unfolds to a full 360°. The five-point snowflake begins with an interior angle of 36° while the six-point snowflake template has an interior angle of 30°.

Instructions:

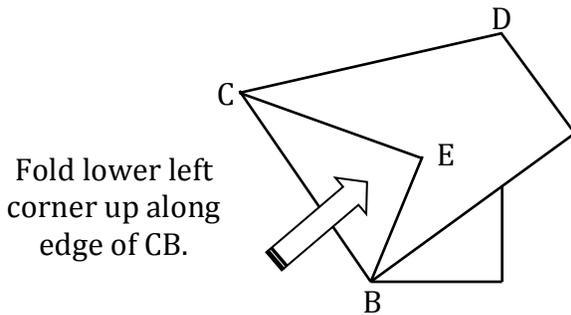Begin with 8½" by 11" paper. Follow each step precisely. Rotating your paper during the folds will result in partial snowflakes.
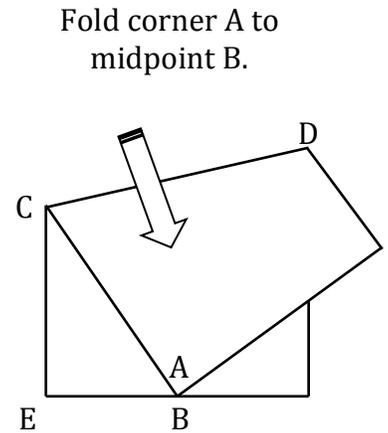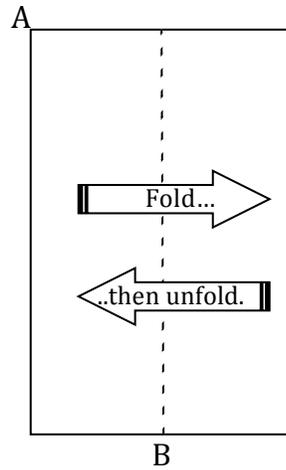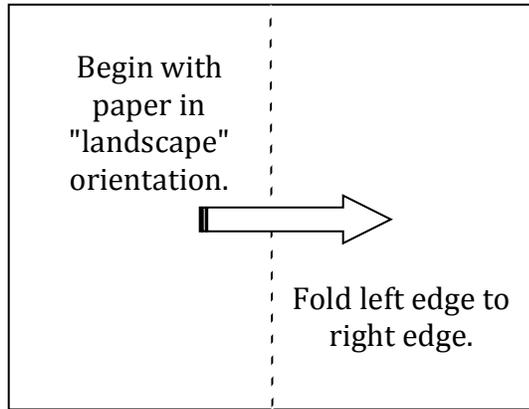
Five-point star
1. Hold the paper in the "landscape" position.
2. Fold the left **edge** to meet the right edge.
3. Your paper should now look like a card with a folded binding on the left. Fold the left "binding" side to the right and then unfold to find the **midpoint** B of the bottom edge.
4. Fold the upper right **vertex** to meet the midpoint B of the bottom edge.
5. Fold the lower left vertex along AB or AC.
6. Lastly **bisect** angle DCB along CE.
7. Cut away the smaller of the two triangles and begin decorating the edges.
8. Note: If you repeat step 6 and bisect the angle again, you can make a ten-point star, but unless you are working with very thin paper, it will be difficult to cut.
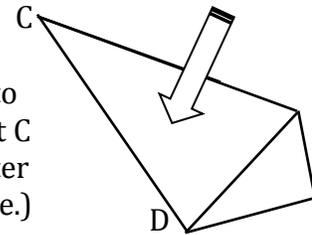
Six-point star
1. Hold the paper in the "landscape" position.
2. Fold the left edge to the right edge.
3. Keeping the folded edge on your left, fold the top down to meet the bottom.
4. You should now have one thick fold at the top and two thinner folds on the left side. Fold the top edge down to meet the bottom edge and then unfold it. Your single thick fold should still be at the top. You will see a horizontal fold marking the **median** of the paper.
5. Now for the tricky part. Fold the lower left point B up to the median so that AB is a straight line. The resulting triangle should have a vertex at point A, which is the upper left corner of the paper.
6. Now bisect angle DAC along line AB. Edge AC should meet edge AD.
7. Cut away the smaller of the waste and begin decorating the edges.
8. Note: If you repeat step 6 and bisect the angle again, you can make a 12-point star, but it will be difficult to cut unless you use very thin paper.
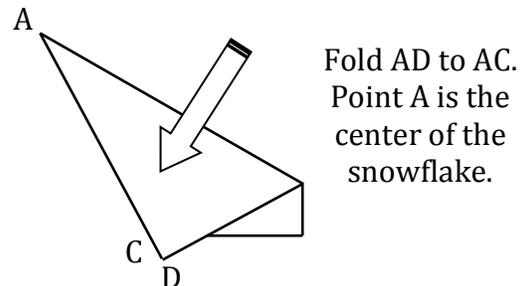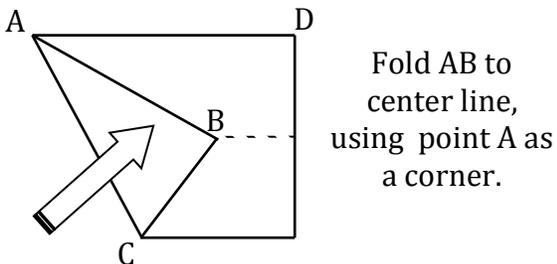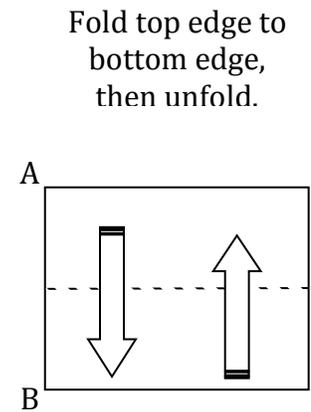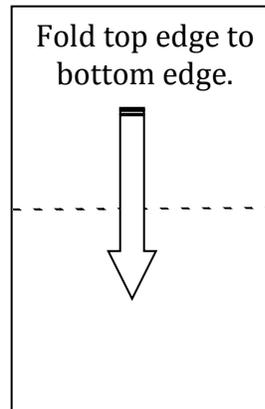
Five-point star:

Begin with paper in "landscape" orientation.

Fold left edge to right edge.

A

Fold...

..then unfold.

B

Fold corner A to midpoint B.

C

D

E

A

B

D

C

E

Fold lower left corner up along edge of CB.

B

C

D

Fold edge CD to edge CB. (Point C will be the center of the snowflake.)

Six-point star:

Begin with paper in "landscape" orientation.

Fold left edge to right edge.

Fold top edge to bottom edge.

Fold top edge to bottom edge, then unfold.

A

B

A

D

B

C

Fold AB to center line, using point A as a corner.

A

C

D

Fold AD to AC. Point A is the center of the snowflake.

Sample cuts

Cut away the waste.

These edges will be
the interior of the
snowflake.

This vertex will
be the center of
your snowflake.

This will be the
outside edge.

waste

Cut straight for a
pentagon or hexagon.

Cut slanted for a star.

Cut once for a star.

Cut designs in
the edges.

Cut again for twice
the points.

Sample 5-point snowflake:

Sample 6-point snowflake: