Quadrilaterals

These activities use **geogebra**, a tool for visualizing mathematics. To use it:

1. Go to **geogebra.org**
2. Click **Start Geogebra**
3. Click **Geometry**

Task 1: Exploring quadrilaterals

A *quadrilateral* is a fancy name for a polygon with four sides. Try some of the following steps to start experimenting with quadrilaterals.

1. Use the **Polygon** tool to create a quadrilateral. Click to create your four corners, then finish by clicking the first corner again.

2. Use the **Midpoint** tool, found underneath the Point tool, to identify the midpoint of each of the sides of the quadrilateral. Click on each side once.

3. Use the polygon tool again to join the four midpoints together. This creates a new quadrilateral which we can call the *midpoint quadrilateral*.

4. Use the **Slope** tool, found under the Angle tool, to calculate some slopes of sides of the midpoint quadrilateral.

5. Use the **Move** tool to change the positions of the original corners, and see how the midpoint quadrilateral changes too.

6. Start over and repeat the above as much as you wish.

7. Perform you own experiments. What if you used a six-sided figure? What other tools can you use?

Task 2: Tiling exploration

A *tiling,* or *tessellation,* is a covering of the plane by shapes with no overlap or gaps. Is it possible to make a tiling using only copies of a quadrilateral? Try some of the following steps to start experimenting with tiling.

1. Create a quadrilateral as before.
2. Use **Menu** > **Edit** > **Copy** and **Paste** to create multiple copies of the same quadrilateral.
3. Use the **Rotate around point** tool to create rotated copies of your quadrilateral.
4. Use the **Reflect about line** tool to create reflected copies of your quadrilateral.
5. Try rotating around a corner 90 or 180 degrees.
6. Try rotating around a midpoint 90 or 180 degrees.
7. Try reflecting around a midpoint.
8. Use the **Move** tool to change the positions of the original corners, and see how the rest of the figures change too.
9. Start over and repeat the above as much as you wish.
10. Perform your own experiments!

Task 3: The midpoint quadrilateral revisited

Here are some ideas to help you explain some of your observations in your exploration.

1. If a and b are any two numbers, the **midpoint** of a and b can be calculated the same way you calculate the average: (a+b)/2. Why is this true?

2. Points in the plane have two coordinates, such as A = (a1, a2).

3. In Geogebra, you can see these coordinates by clicking **Menu** > **View** > **Algebra**. Take a look at the coordinates of all the points in your figure. How is the midpoint of a segment calculated from its endpoints?

4. If A and B are any two points in the plane, the midpoint of A and B can be calculated using the averages of the two coordinates: (A+B)/2 = ((a1+b1)/2, (a2+b2)/2). Can you see this reflected in the numbers?

5. If P and Q are any two points in the plane, the slope of the line joining P and Q can be calculated as *rise*/*run*, which means (p2-q2)/(p1-q1). Can you see this reflected in the numbers?

6. If you call the corners of the quadrilateral A,B,C,D, and the corners of the midpoint quadrilateral (A+B)/2, (B+C)/2, (C+D)/2, (D+A)/2, then what are the slopes of opposite sides of the midpoint quadrilateral?