

The Four-Color Problem

How many colors are needed to color a map? In order to make a map that is easy to read, no countries that share a border may be shaded the same color. Are there set rules that govern this? Is it possible to find exceptions to those rules? Let's explore this problem and perhaps even our own roots in the process.

- 1) Can you draw a map where two colors are enough? How about three colors?
- 2) Can you draw a map that needs four colors?
- 3) Play the Four-Color Game with a friend. Document your games and observations.

The Four-Color Game

Two players take turns. Only four colors are allowed. The first player draws a country, colors it, then draws a second country and leaves it blank. The second player colors the blank country and draws another country that is left blank. Players take turns coloring in the blank country and adding one of their own until either there is no space left on the paper or a player is forced to use a fifth color.

- 4) Is it possible to draw a map that would require more than four colors?
- 5) Let's look at some real world maps. Do a little research, find a map of a continent, country, state, or region, and see how many colors are used. If you are not sure which map to pick, choose one that ties into your own roots.
- 6) While looking at flat maps on paper can teach us a lot, the world itself is not flat. Consider the shape of a sphere. Is it possible to create a map on a sphere that would require more than four colors? How can you show that on paper?
- 7) Imagine a world shaped like a donut! If such a world were to exist, would it change the four-color problem at all? How and why?

After viewing the Numberphile video "The Four Color Map Theorem" take a crack at the following problems.

- 8) Use the grid system explained in the video to draw a grid of a real continent, country, or state.
- 9) Explain, in your own words, the theorem presented in the video and how it allows us to prove that four colors are all that will be needed for flat maps.
- 10) Have fun exploring various ways of coloring maps and search for interesting real-world maps to color.