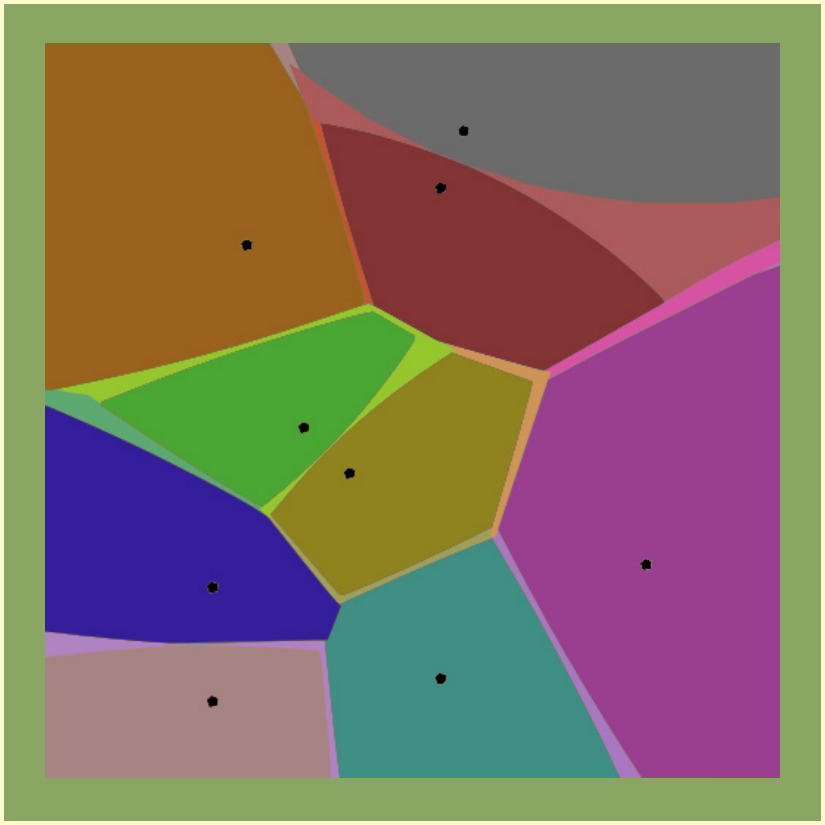
STEM Sims™

Fueling Station



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Do you need an idea for a scientific study?
Try out one of our ideas or make one of your own.

Start learning right now about Voronoi diagrams and their everyday applications. Take the following brief quiz to see how much you already know about geometric algorithms. See the bottom of page 4 to check your answers.

1. Which Voronoi formula for distance is stated as the square root of $((a_1-b_1)^2+(a_2-b_2)^2)$?
   a. Cartesian
   b. Euclidean
   c. Manhattan
   d. Newtonian

2. Which Voronoi formula takes into account a grid pattern, also known as taxicab geometry?
   a. Cartesian
   b. Euclidean
   c. Manhattan
   d. Newtonian

3. Who used a Voronoi diagram to identify the source of a cholera epidemic in 1854?
   a. Rene Descartes
   b. Peter Gustav Lejeune Dirichlet
   c. John Snow
   d. Alfred H. Thiessen

4. Which Photoshop function most closely resembles creating a Voronoi diagram?
   a. Filter>Sketch>Reticulation
   b. Filter>Brush Strokes>Sumi-e
   c. Filter>Artistic>Palette Knife
   d. Filter>Pixelate>Crystallize

5. Which of the following is the mathematical symbol for perpendicular?
   a. ⊥
   b. ∥
   c. ∠
   d. ⌞

Tessellation Time

Materials Required:

ruler

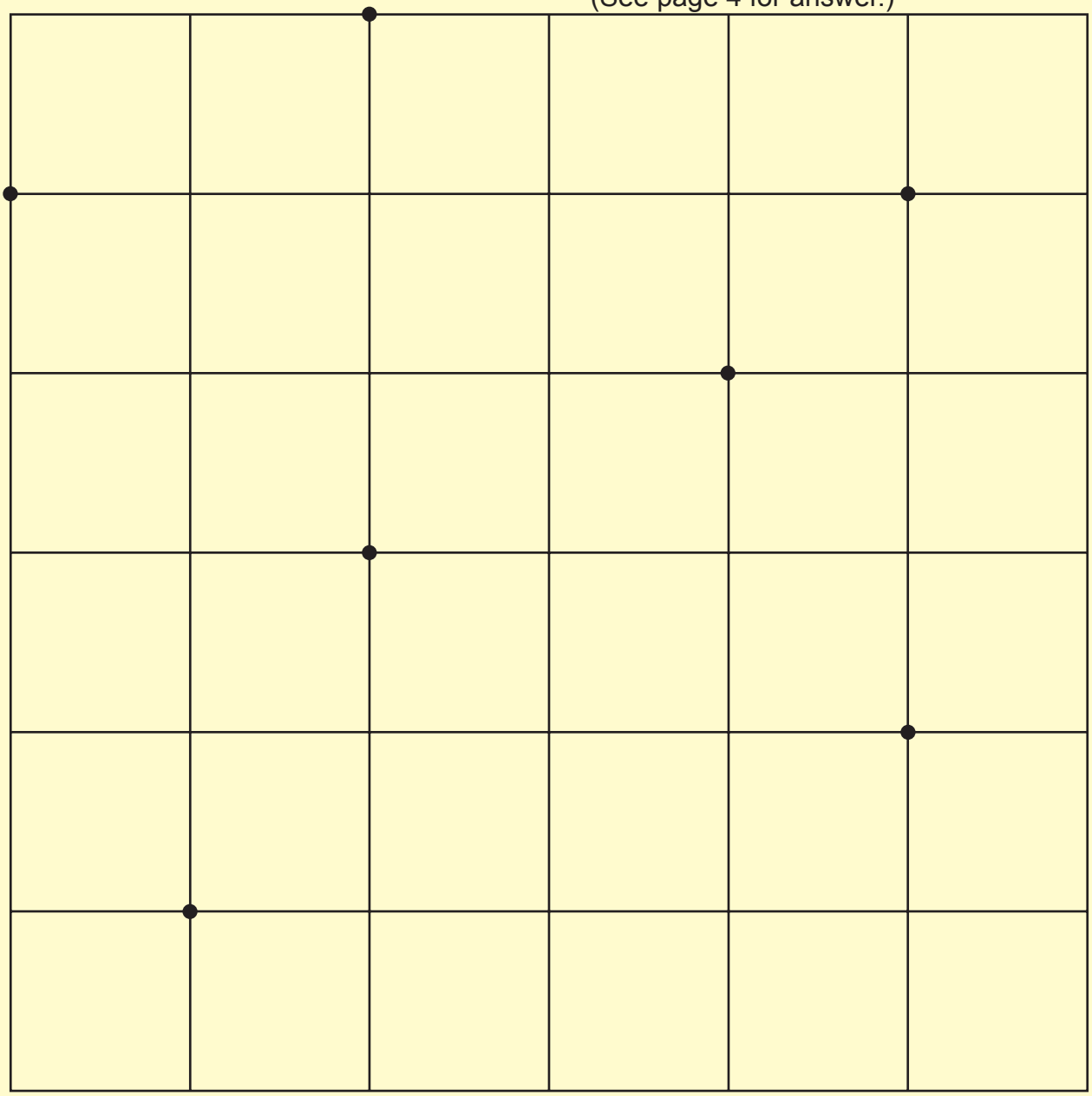
colored pencils

protractor

Instructions:

1. Trace the grid below onto another paper.
2. Connect the nearest neighboring dots with a red pencil. Do not let any lines overlap.
3. Find the midpoint of each line you drew and mark it with a green pencil.
4. Use your protractor to find the angle perpendicular to your line and draw perpendicular bisectors at each midpoint in blue.
5. Finally, outline each Voronoi cell for each point in violet.

(See page 4 for answer.)



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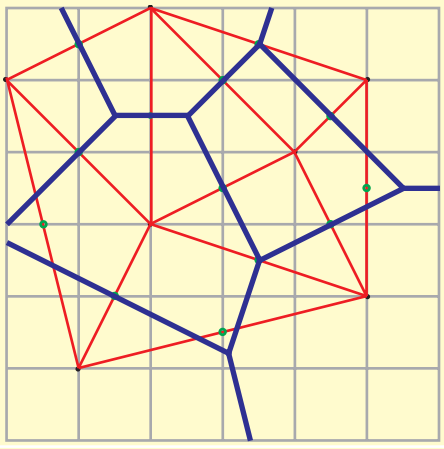
Geometry Rules!

There are a lot of situations where optimizing your space is required. For example, consider a chain of stores that currently has three locations in your city. The parking lots are always full and the employees have noticed customers complaining about long checkout lines. What is there to be done? Well, a fourth location could be added. But where? If it's placed too close to another store it could be removing too many customers from an already existing site. In order to solve dilemmas like this, Voronoi diagrams can be used.

Voronoi diagrams are created by using a set of pre-selected data points. The shortest paths of points are first generated and then the midpoint of each path is found. After finding each midpoint, perpendicular bisectors are drawn to determine the Voronoi cells. Each cell surrounding a data point is made up of all of the points that are closer to that point than any other. The sizes of the cells are determined by the number of data points as well as the distances between them. Most Euclidean distance diagrams end up looking like mosaics.

There are so many applications for calculating these distances. Rene Descartes first used a similar method in 1644 to analyze how gravity worked between stars. This algorithm can also be used to calculate amount of rainfall per square mile, predict forest fire patterns, diagnose tumor cells, evaluate protein volume, and so much more. And all it requires is a basic understanding of geometry.

Terms and concepts you need to understand are line segments, a finite line between two points; slope, the distance up and down over the distance left and right (rise over run); midpoint, the point exactly at the middle of a line segment; and perpendicular bisector, the line that goes through the midpoint of a segment and forms a 90 degree angle (hence perpendicular) to the segment, splitting the segment in half (hence bisector). Go find your own applications, lickety-split!



Please visit our site for more helpful information:
STEMsims.com

Answers: **Page 2 Answers:** 1) b. 2) c. 3) c. 4) d. 5) a. **Page 3 Answer:**

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