**Solving Problems with Geogebra**

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GeoGebra is an interactive program that can be used as a tool in teaching and learning geometry, algebra, calculus, and more. The program available as a free download onto your tablet or computer and can be accessed online (with no download) through the Chrome App. In addition, there are literally thousands of links to materials that can be used in the classroom.

The program and materials are available at http://www.geogebra.org/.

Tutorials and Manuals are available at http://wiki.geogebra.org/en/Main_Page .

Of particular interest are:

>   Quick Start Guide for Window Tablet App:
>   http://www.geogebra.org/help/geogebraquickstart-win8-en.pdf
>
>   Quick Start Guide for Desktop:
>   http://www.geogebra.org/help/geogebraquickstart_en.pdf

Below are some problems for which GeoGebra can be used as a valuable tool in the problem-solving process.

1.  (a) Find all values of *m* such that the system of equations below has a solution.
$$\begin{cases} 2x = 3y - 7 \\ -5x + y = 6 \\ y = mx + 1 \end{cases}$$
    (b) Find all values of *b* such that the system of equations below has a solution.
$$\begin{cases} 2x = 3y - 7 \\ -5x + y = 6 \\ y = 4x + b \end{cases}$$

2.  For what values of *a* does the system of equations

$$\begin{cases} x^2 - y^2 = 0 \\ (x - a)^2 + y^2 = 1 \end{cases}$$ have no solutions?

    Find all values of *a* for which the system has a unique solution. When does it have exactly two solutions? Exactly three solutions? Exactly four solutions? More than four solutions?

3.  (a) Using only the circle and segment tools in GeoGebra, construct a rhombus. What can you say about the diagonals of a rhombus? A square is a special kind of rhombus. What distinguishes the diagonals of a square from the diagonals of a rhombus that is not a square?
(b) Using only the circle and segment tools in GeoGebra, construct a kite. A rhombus is a special kind of kite. What distinguishes the diagonals of a rhombus from the diagonals of a kite that is not a rhombus?

4.  Let *ABCD* be an arbitrary quadrilateral.   Let *E*, *F*, *G*, and *H* be midpoints of the sides of the quadrilateral.
(a)  What can you say about the quadrilateral *EFGH*?
(b)  If *ABCD* is a kite, what can you say about *EFGH*?
(c)  If *EFGH* is a rhombus, what can you say about *ABCD*?

5.  City A and City B sit on the same side of a river. A power plant is to be built on the banks of the river and lines will be run from the power plant to supply power to both cities. Where should the plant be built if the total length of the power line is to be as small as possible?



river

One possible location
for the power plant
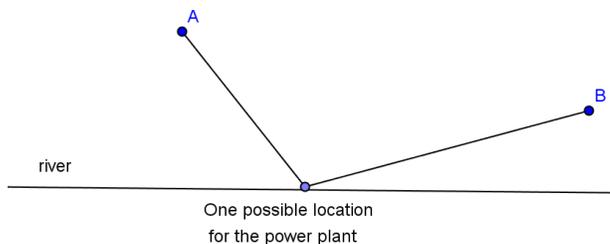
6.  Draw a rectangle and trace the path of a billiard ball that begins in the lower left corner and initially travels upward at a 45-degree angle. Assuming that the ball bounces off the walls at perfect 45-degree angles, which corner does the ball reach first? What fraction of all the unit squares within your rectangle does the ball pass through on its way? Start your experiment with a rectangle having width 3 and height 5, then choose other dimensions. What will happen if the width is m and the height n units for some positive integers m and n?

7.  For what values of *c* does the equation $6x - 9y = c$ have integer solutions (solutions for which both *x* and *y* are integers)?  Pick one such value of *c* and describe the set of all solutions as simply as possible.

8.  Let *n* be a positive integer.  Determine how many integer solutions are there to the system of inequalities:
$$x + y > \frac{n}{2}$$
$$0 < x < \frac{n}{2}$$
$$0 < y < n/2.$$