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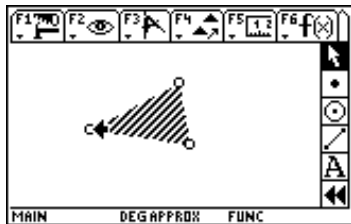
Triangles: Law of sines and cosines  
**Heron's Formula**

**NCTM standard:** Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

Analyze properties and determine attributes of two- and three-dimensional objects.

Introduction: This application shows how to derive the area of a triangle given the three sides.

- 1) Turn the calculator on.
- 2) Press [APPS]. Press 1:FLASHAPPS:Sketchpad, and then press [ENTER].
- 3) Make a triangle. Press [2nd] [F3] for the Toolbox, and go to the point tool (second down). Press [ENTER]. Make three points by moving the cursor to three different non-collinear locations and pressing [ENTER] after each time. Press [ESC], then highlight each point by pressing [ENTER] on them. Press [F3] and then press C:Polygon interior. Press [ESC].



- 4) Find the area. Press [ENTER] on the interior of the triangle. Press [F5] 6:Area. Record the value displayed.
- 5) Find the perimeter. Press [ESC], then highlight the interior of the triangle. Press [F5] 3:Perimeter. Record the value, and then calculate half of the perimeter. Record that value as well.
- 6) Measure the length of each side, but first, hide the measurements. Press [F2] 1:Hide. Highlight the area measurement by pressing [F2] 1:Hide. Press [ESC]. Measure the left side of the triangle, call it side 1. Highlight the left and top vertices, press [F5] 2:Distance. Record the value. Press [ESC]. Repeat for the right side of the triangle, and record this value as side 2. Then repeat for the measurement process for the bottom of the triangle, and record the value as side 3.
- 7) If  $\frac{1}{2}$  perimeter is  $s$ , and the three sides are  $a$ ,  $b$ , and  $c$ , calculate  $s-a$ ,  $s-b$ ,  $s-c$ , and record the value for each.
- 8) Take the three totals from #7, multiply them together, then multiply that value by  $s$ . Compare that to the area of the triangle. Do you see any connection? If so, what?

9) Take the square root of the total in 8. Compare *that* to the area. What do you observe?

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10) You have just used Heron's formula to calculate the area of a triangle. If A is used for area, then use A, s, a, b, and c to write Heron's formula based on the calculations above.

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	Area	Perimeter	Side 1 (a)	Side 2 (b)	Side 3 (c)	( $\frac{1}{2}$ ) perimeter (s)	s-a	s-b	s-c