Geometry Lab Activities with the TI-92

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Helpful Hints for using Cabri on the TI-92

1. You choose a tool first and then use it. You can keep using it repeatedly until you pick another tool.

2. Tools work according to Euclidean Geometry definitions. In other words, you create a triangle by defining 3 points; a line by defining 2 points. You measure angles by locating 3 points, with the vertex second.

3. Objects can only be moved based on where you have defined them. That means that if you create a point on a line, it can only be dragged up and down that line. If you want to use the point to move the line from side to side, then define the point first, and draw the line through it. (Note: if you hold down the hand button, all independent/movable points will flash.)

4. The ESC button on your keyboard is a quick way to get the pointer tool, used for selecting and dragging objects. When you use the pointer, the object you selected will flash.

5. To delete objects:
   A. To undo the last operation only, choose UNDO (F8 #D), or press ◊Z

   B. To delete one object, select it with the pointer tool, and use the backspace key.

   C. To clear the screen without saving, choose CLEAR ALL (F8 #8).

   *Note: If you delete an object, any object or measurement that was dependent on the deleted object will also disappear.

6. To LABEL objects easily, type a letter immediately after creating a point, line, or circle.

7. Use the + and – keys to add or remove digits of precision in numerical values.

8. Use ◊ON to turn off the calculator without leaving the Cabri Geometry program.

9. As the number of objects on your screen increases, the calculator takes longer to respond. Consider HIDING some objects (F7 #1).

10. Some features for computer users:
    A. In the EDIT menu, choose REPLAY CONSTRUCTION to see a student's work step by step from the beginning. Use the right and left arrow keys on the keyboard to advance and back up each step.

    B. In the OPTIONS menu, choose PREFERENCES to make any of a number of adjustments that you may find useful. You can always reset these to the factory defaults.

Interior and Exterior Angles of a Triangle

Teaching Notes

Geometry Topics:
1. Sum of angles of a triangle
2. Exterior angle = sum of remote interior angles

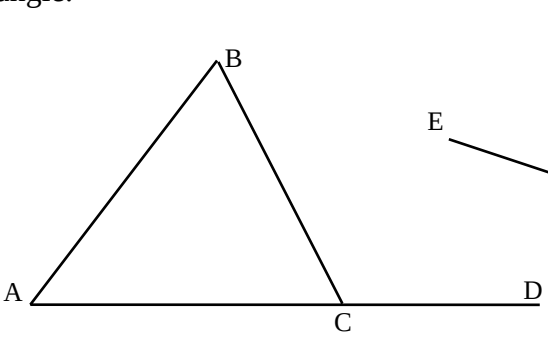
Prerequisite Skills: Identifying exterior, remote interior, and adjacent interior angles. Classifying triangles as acute, right or obtuse.

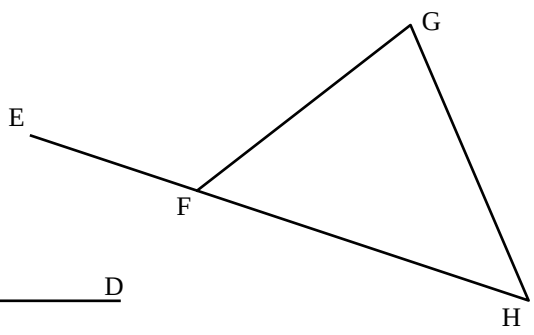
Key TI-92 Tools: Triangle (F3 #3), Line (F2 #4), Label (F7 #4), Angle Measure (F6 #3), Calculate (F6 #6)

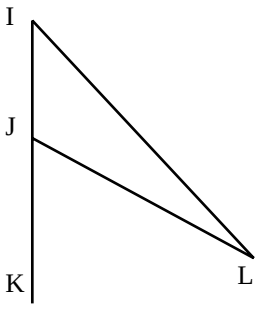
Procedure Notes:

Lab Activity—Interior and Exterior Angles Name_____
Partner _____

WARMUP:
On each figure below, label the exterior angle, the 2 remote interior angles, and the adjacent interior angle.







PROCEDURE:
On the calculator, you will create an acute triangle with its bottom edge on a line, like the figure above on the left. Then you will measure the four angles and collect data

1. Choose the **line** tool (F2 #4) and draw a line on your screen by clicking ENTER in two places.

2. Choose the **triangle** tool (F3 #3), and create a triangle whose bottom edge is on the line. To do this, wait for the message "on this line" before clicking ENTER. Type an "A" after your first click, a "B" after your second click, and a "C" after your third click so that the triangle will be labeled ABC.

3. If you forgot to label the triangle, choose the **label** tool (F7 #4). Wait for the message "this point", click ENTER and type the letter for each vertex.

4. Choose the **point** tool (F2 #1) and create a new point on the line to the right of your triangle. Label it point D.

5. Choose the **angle measure** tool (F6 #3) and measure the 3 interior angles of the triangle and the exterior angle. To measure an angle, click ENTER on 3 points, with the vertex of the angle 2nd, and wait for the right messages. Record this data in the first row of the chart on the next page.

6. Use the **pointer** tool and the **hand** tool to pull on the vertex of your triangle that is not on the line. Make your triangle into an obtuse triangle. Then record the new angle measures in the chart.

7. Create two more triangles by pulling on a vertex of your triangle. Record your data in the chart, and classify each triangle as acute, obtuse or right.

COLLECT DATA:
Fill in the symbols for each of your angles in the top row. Complete the chart with your angle measurements and triangle classifications.

Type of Triangle ↓	Measure of Exterior Angle <	Measure of Remote Interior <	Measure of Remote Interior <	Measure of Adjacent Interior <
Acute				
Obtuse				

MAKE CONJECTURES:

8. Use the **calculate** tool (F6 #6) and find the sum of the 3 angles of the triangle. Don't type numbers. Use the **up/down cursor** to choose measurements that are on the screen, and click ENTER to use a highlighted number. Use the addition button on the calculator and click ENTER when done.

   Sum of the 3 interior angles of the triangle:_____

   What happens to this result when you make changes to the shape of your triangle?

   _____

   What theorem justifies your answer above? _____

9. Make some observations about the information in your chart. Do you notice any relationships between the exterior angles and either type of interior angle?

   _____

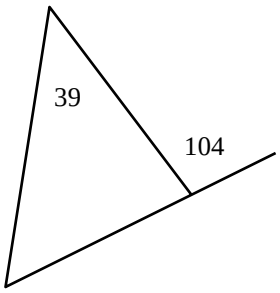
   _____

   _____

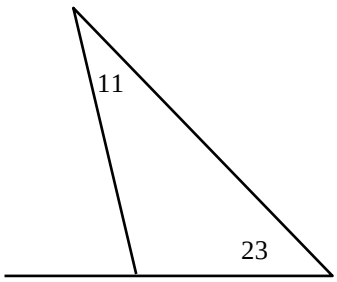
   _____

APPLY THE MATH:
Find the missing angle measures in the triangles below. Show work!

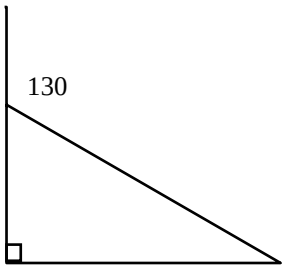
1.



2.



3.



4. Create your own problem like #1–3 above with a diagram and fill in the angle measures.

EXTENSION:
Create a new triangle that has one exterior angle at each vertex using this procedure:

Clear your screen (F8 #8) and create a new line (F2 #4). Choose the **segment** tool (F2 #5) and create a segment with one endpoint on the line (wait for the right message). Then create a second segment with one endpoint on the segment and the other endpoint on the line.

Make some measurements, and make a labeled sketch below.

What do you observe to be true about these three exterior angles?

_____

Similar Figures and Dilations

Teaching Notes

Geometry Topics: 1. Similar Figures and their ratios of side lengths, perimeters and areas.
2. Dilations.

Prerequisite Skills: Definition of similar figures, scale factor, image and pre-image.
Using proportions to find missing values.

Key TI-92 Tools: Numerical Edit (F7 #6), Dilation (F5 #3), various Measurement tools (F6)

Procedure Notes:

Don't confuse the **dilation** tool (F5 #3) in the Transformation Menu (F5) with the dilate pointers in the Pointer Menu (F1).

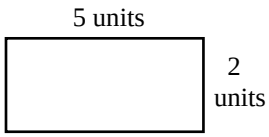
The calculator can only measure areas of closed figures. Make sure students create their triangles using the **triangle** tool (F3 # 3) and not from individual segments.

Students can answer parts D and E of the APPLY THE MATH section using proportions or scale factors. If proportions are desired, have students answer parts A, B, and C in fraction form.

Lab Activity—Dilations

Name _____
Partner _____

WARMUP:
Multiply each side length of this rectangle by a scale factor of 3, and sketch what the new rectangle would look like.



PROCEDURE & COLLECT DATA:
On the calculator, you will create a triangle and make several measurements. Then you will create a dilation image with different scale factors and make measurements on the image triangle.

1. Choose the **triangle** tool (F3 #3) and create a triangle by clicking ENTER in three places. Place a point in the interior of the triangle using the **point** tool (F2 #1). Choose **Numerical Edit** (F7 #6) and click ENTER near the top edge of your screen. Then type the number 2.

2. Make several measurements of your triangle using the tools in the **Measure** menu (F6).
   - The **distance and length** tool (F6 #1) can measure a side length by clicking on its two endpoints and also can measure perimeter by clicking on a side of your triangle. Wait for the right message.
   - The **angle** measure tool (F6 #3) works by clicking ENTER on 3 points, with the vertex of the angle 2nd.
   - The **area** tool (F6 #2) works by pointing to your triangle and clicking ENTER.

Record your results below.

length _____ angle _____ perimeter _____ area _____

3. The **dilation** tool (F5 #3) works by selecting a figure to dilate, a point as the center of dilation, and a numerical scale factor. Perform a dilation using the scale factor 2 on your triangle. You will need to click ENTER on the triangle, then on the interior point, and then on the number 2 to perform the dilation. Wait for the right messages.

   What do you observe on your screen? Describe the dilation in words, and make a sketch:

   _____

   _____

   _____

4. Make several measurements of your new triangle. Record your results below.

length _____ angle _____ perimeter _____ area _____

5. Choose the **calculate** tool (F6 #6) to divide each of your measurements from the new triangle by the original triangle's measurements. Don't type numbers. Use the **up/down cursor** to choose measurements that are on the screen, and click ENTER to use a highlighted number. Use the division button on the calculator and click ENTER when done.

Record these ratios below.

length ratio _____	angle ratio _____	perimeter ratio _____	area ratio_____

6. What do you observe about these ratios and your original scale factor? Can you make any conjectures?

_____

_____

7. Choose your **pointer** tool (F1 #1) and click ENTER twice on your scale factor 2. Change it to a 3 and observe what happens to your measurements and ratios.

length _____ angle _____ perimeter _____ area _____

length ratio _____	angle ratio _____	perimeter ratio _____	area ratio_____

8. Change your scale factor to a value between 0 and 1. scale factor I used _____

What happens to your image triangle? _____

Make the same measurements and calculate the same ratios.

length _____ angle _____ perimeter _____ area _____

length ratio _____	angle ratio _____	perimeter ratio _____	area ratio_____

Continue changing scale factors and making measurements until you feel you can answer the following questions.

MAKE CONJECTURES:

9. What do you observe to be true about the length ratio?

_____

_____

10. What do you observe to be true about the angle ratio?

_____

_____

11. What do you observe to be true about the perimeter ratio?

_____

_____

12. What do you observe to be true about the area ratio?

_____

_____

APPLY THE MATH:
Two dilation figures have corresponding sides with lengths 14 and 20.

A. What is the ratio of their perimeters? _____

B. What is the ratio of their angle measures? _____

C. What is the ratio of their areas? _____

D. If the smaller perimeter is 40, what is the larger perimeter? Show work!

_____

E. If the larger area is 130, what is the smaller area? Show work!

_____

LAB: Lines and Points of Concurrency in Triangles

Teaching Notes

Geometric Topics: 1. Altitude, angle bisector, perpendicular bisector and median lines in a triangle.

2. Points of concurrency: orthocenter, incenter, circumcenter and centroid.

Prerequisite Skills: definitions of above terms.

Key TI-92 Tools: Triangle (F3 #3), Line (F2 #4), Perpendicular Line (F4 #1), Midpoint (F4 #3), Segment (F2 #5), Angle Bisector (F4 #5), Intersection Point (F2 #3), Macro (F4 #6), various Measurement tools (F6), Check Property (F6 #8), Circle (F3 #1)

Procedure Notes:

CREATING A MACRO: Centroid

A macro allows you to save a frequently needed or complex construction into one step for later use. You need to perform the construction first, then define "initial objects" and "final objects."

1. Create a triangle (F3 #3), find the midpoints of the sides (F4 #3), construct the median segments (F2 #5). Also create an intersection point (F2 #3) for your centroid.

2. Choose **Macro** (F4 #6), and select the choice "Initial Objects" (#2). Point to your original triangle and press Enter so that the triangle is highlighted.

3. Again, choose **Macro** (F4 #6), and select the choice "Final Objects" (#3). Point to your 3 segments in turn and your intersection point, pressing Enter in between. Make sure you have the correct message. All four objects should be highlighted.

4. Again, choose **Macro** (F4 #6), and select the choice "Define Macro" (#4). Enter a name and object name (these can be the same), press Enter, and then enter a name to save your Macro to a file.

5. To use the Macro, construct any triangle (the initial object), then choose **Macro** (F4 #6), and select the choice "Execute Macro" (#1). A pop-up menu will appear with all available macros. Select the one you want, then select the triangle to execute the macro.

**Please note:

- It is not necessary for students to know how to create a macro to complete the lab successfully.
- This activity is well-suited for a project rather than a lab; simply revise the lab sheets to have students investigate one of the points of concurrency with general guidelines:
  1. Where is your point located with respect to the triangle? Does its location depend on the type of triangle created? Describe what happens when you pull on a vertex.
  2. Where is your point located on its line or segment? Make some measurements. Is it always a certain distance from a side or vertex?

  Students then turn in sketches and conjectures, and can present findings to the class.

Lab—Lines and Points of Concurrency in Triangles Name_____
Partner _____

WARMUP:
Definitions: (make sure you relate these to the parts of a triangle!)

Median _____

Altitude _____

Angle Bisector_____

Perpendicular Bisector_____

Centroid–Point of concurrency of 3 medians
Incenter– Point of concurrency of 3 angle bisectors
Circumcenter– Point of concurrency of 3 perpendicular bisectors
Orthocenter– Point of concurrency of 3 altitudes

PROCEDURE:
Tools to Use:

- The Construction Toolbox (F4) contains tools to create perpendicular lines, midpoints, perpendicular bisectors, and angle bisectors.

- The Measurement Toolbox (F6) contains tools to measure segments, areas, angles, and perform calculations on the measurements.

- The Display Toolbox (F7) contains the Label tool to name points and the Hide/Show tool to hide objects which clutter your drawing.

COLLECT DATA & MAKE CONJECTURES:
Part A:
Create a **triangle** (F3 #3) and label its vertices A, B, and C. Choose one vertex, and construct the median, altitude, and angle bisector from it to the opposite side. Then use your pointer tool to change your triangle's shape. Make sure you change it into acute, right, and obtuse triangles. Answer the following questions, and make sketches below:

1. What do you notice about the location of the three segments?

Part A, cont.

2. Does their location depend on the type of triangle you create (acute, right, obtuse)?

3. Are these three segments ever the same segment? If so, when?

4. Does the angle bisector bisect anything else? Ever?

5. Do any of these segments divide the triangle into congruent triangles? Or into triangles with equal areas?

6. Does the perpendicular bisector of the side opposite your vertex have anything in common with the segments you have drawn? Ever?

7. Sketches: (these 3 are required, but make any others you think are important)

Acute Triangle Right Triangle Obtuse Triangle

Part B:
Create a new triangle, and investigate the properties of the CENTROID. Draw the three needed lines for your triangle, and put a point at their intersection. Label it by its name (you may need to use the hand icon with the label tool to get a better shape for your label).

8. Where is your point located with respect to the triangle? Does its location depend on the type of triangle created? Describe what happens when you pull on a vertex of your triangle.

9. Make at least one sketch:

10. The centroid separates each median segment into 2 different size segments.

    Measure the two parts of one of your medians. _____ and _____

    Use the Calculator tool to find the ratio of these two measurements. _____

    Does this ratio hold true for your other medians?

Part C:
Create a new triangle, and investigate the properties of the ORTHOCENTER. Draw the three needed lines for your triangle, and put a point at their intersection. Label it by its name.

11. Where is your point located with respect to the triangle? Does its location depend on the type of triangle created? Describe what happens when you pull on a vertex of your triangle.

12. Make at least one sketch:

Part D:
Create a new triangle, and investigate the properties of the INCENTER. Draw the three needed lines for your triangle, and put a point at their intersection. Label it by its name.

13. Where is your point located with respect to the triangle? Does its location depend on the type of triangle created? Describe what happens when you pull on a vertex of your triangle.

14. Make at least one sketch:

Part E:
Create a new triangle, and investigate the properties of the CIRCUMCENTER. Draw the three needed lines for your triangle, and put a point at their intersection. Label it by its name.

15. Where is your point located with respect to the triangle? Does its location depend on the type of triangle created? Describe what happens when you pull on a vertex of your triangle.

16. Make at least one sketch:

EXTENSION:
You may have noticed that three of the points of concurrency have the word "center" as part of their names. Two of them are centers of circles that are related to the original triangle in some way. Find out which two, and discover the properties of their circles.

Other Ideas for Demonstrations, Labs & Projects

Class Demonstrations:

- Distance from a point to a line
- Parallel Lines cut by a Transversal (also good as a lab)
- Special Angle Pairs (vertical angles, linear pairs, complementary)
- Interior Angles of a Quadrilateral (or other polygons, also exterior angles)

Labs:

- Reflections on the Coordinate Plane
- Translations and Vectors
- Rotating Polygons
- Pythagorean Theorem and its Converse
- Circles–Finding Pi
- Angles in a Circle
- Trigonometric Ratios

Projects:

- Properties of Quadrilaterals (excellent to have each group become experts on one type of quadrilateral and then present findings to the class).
- Tesselations & Regular Polygons (good follow-up to Translations & Vectors and Quadrilaterals)
- Midsegments of Triangles and Quadrilaterals
- Quadrilaterals Inscribed in a Circle; Relationship between Circles and Regular Polygons

Use your imagination and design activities that suit your curriculum. You do not need to have printing capability (via GraphLink); student sketches work very well. The most important thing (I think) is to have the students be accountable for their work by turning in a lab report, presenting findings to the class, taking notes, etc.