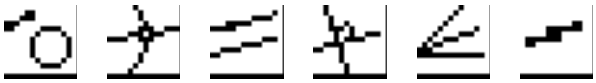
EXPLORATIONS ™

Activity 1

Objective

- To Use Cabri® Jr. tools to perform simple constructions

Cabri® Jr. Tools



Simple Constructions

Introduction

The **Constructions Tools Menu** (**F3 Menu**) in Cabri Jr. contains tools for operating on other objects. This activity will provide practice using several of them.

This activity makes use of the following definitions:

The **median** of a triangle is a segment connecting a vertex to the midpoint of the opposite side.

The **altitude** of a triangle is a segment from a vertex perpendicular to the opposite side or an extension of the opposite side of the triangle.

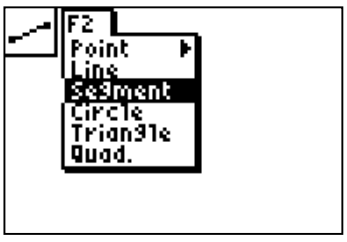
Construction

Part I: Construct a parallelogram

Construct a segment and label its endpoints.

1. Press WINDOW to view the **Drawing Tools Menu** (**F2 Menu**), and then highlight **Segment**. Press ENTER.

   Note: *The tool icon at the top left of the screen indicates that the* ***Segment*** *tool is active.*



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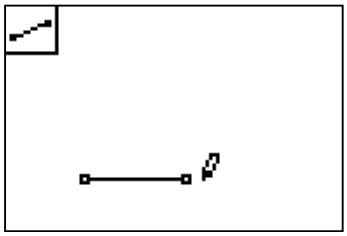
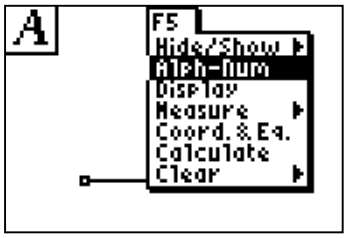
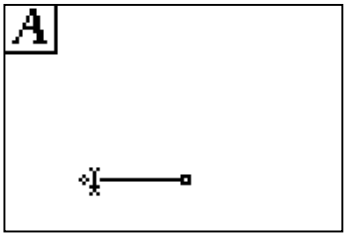
2. Move the cursor to the lower left area of the screen and press [ENTER] to create the first endpoint of the segment there. Move the cursor to the lower middle area of the screen, and press [ENTER] to create the second endpoint there.



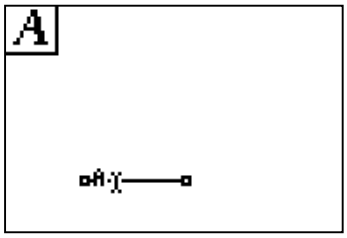
3. Press [GRAPH] to view the **Display Tools Menu** (**F5 Menu**), and then highlight **Alpha-Num**. Press [ENTER].



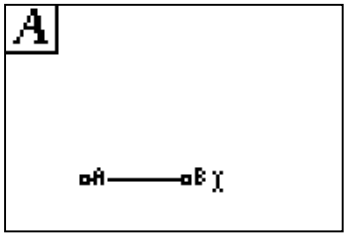
4. Move the cursor to the left endpoint of the segment. The point blinks when the cursor is close enough to the point to select it.



5. Press [ENTER] to create a label for this point. Press [MATH] to label the point *A* (note that the Alpha lock is on), and then press [ENTER] to complete the label.



6. Repeat this procedure to label the other endpoint *B* (B is above [APPS]). When complete, press [CLEAR] to exit the **Alpha-Numeric** tool.



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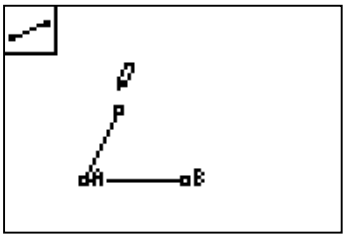
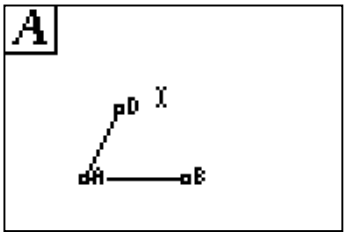
Construct a second segment with common endpoint *A*.

7. Use the **Segment** tool (WINDOW, **F2 Menu**) to create a segment with one endpoint at *A*. Move the cursor to point *A*, press ENTER. Move the cursor up and to the right, and press ENTER again.



8. Use the **Alpha-Numeric** tool (GRAPH, **F5 Menu**) to label the new endpoint as *D* (D is above x^{-1}). Remember to press ENTER once to create the label and then again to complete the label.



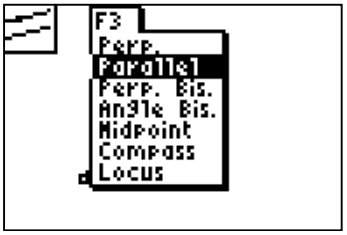
Create a line through point *D* parallel to segment $\overline{AB}$.

To use the **Parallel** tool, you must do the following:

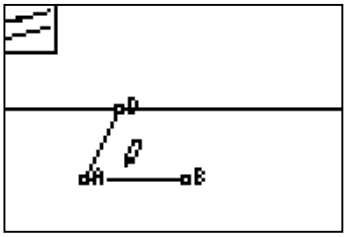
- Select the point through which the parallel line will be drawn.
- Select the line or segment to which the new line will be parallel.

The order of the selection does not matter.

9. Press ZOOM to view the **Construction Tools Menu** (**F3 Menu**), and then highlight **Parallel**. Press ENTER.



10. Move the cursor to point *D*, and press ENTER. Move the cursor to segment $\overline{AB}$ and press ENTER. A line is drawn through *D* parallel to segment $\overline{AB}$.



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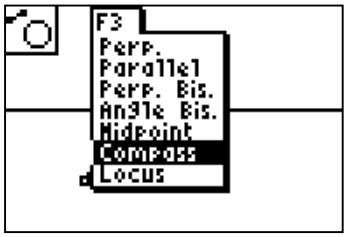
Use the **Compass** tool to copy the distance from *A* to *B* to the parallel line.

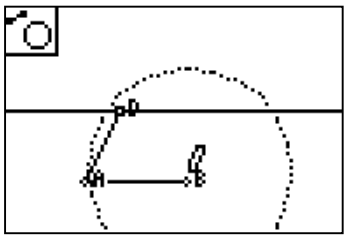
To use the **Compass** tool, you must do the following:

- Select the radius to be copied, either by selecting a segment or by selecting two endpoints.
- Select the center point from which to draw the compass circle.

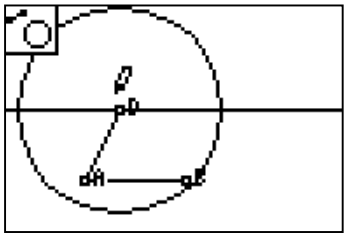
11. Press ZOOM to view the **Construction Tools Menu** (**F3 Menu**), and then highlight **Compass**. Press ENTER.



12. Move the cursor to point *A*, and press ENTER. Move the cursor to point *B*, and press ENTER. A compass circle will appear and move with the cursor.

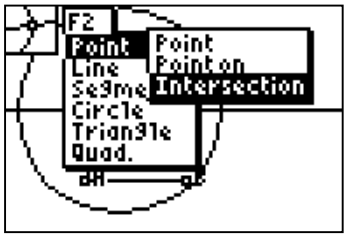


13. Move the cursor to point *D*, and press ENTER. The compass circle will be anchored and centered at *D*.



Create and label the intersection point and complete the quadrilateral.

14. Press WINDOW to view the **Drawing Tools Menu** (**F2 Menu**), and then highlight **Point**. Press ▶ to view the **Point Menu**. Highlight **Intersection**, and press ENTER.



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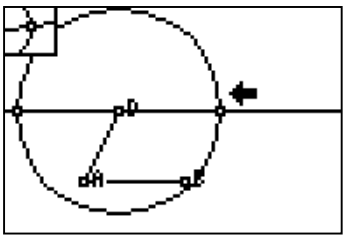
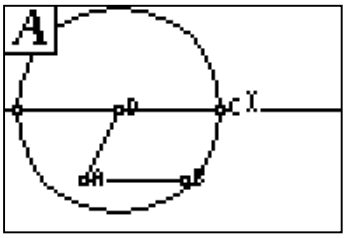
15. Move the cursor to the intersection of the compass circle with the parallel line, and press ENTER to create an intersection point there.

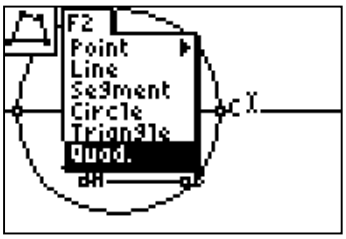
Note: *Both intersection points are created at the same time.*



16. Use the **Alpha-Numeric** tool (GRAPH, **F5 Menu**) to label the new point as *C* (C is above PRGM). Remember to press ENTER once to create the label and then again to complete the label.

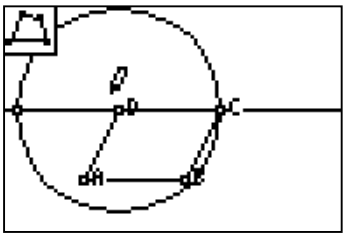


17. Press WINDOW to view the **Drawing Tools Menu** (**F2 Menu**), and then highlight **Quadrilateral**. Press ENTER.



18. Move the cursor to point *A*, and press ENTER. Move the cursor to point *B*, and press ENTER. Move the cursor to point *C*, and press ENTER. Move the cursor to point *D*, and press ENTER.

Note: *Be careful to select the point itself, not the label.*



Hide the line and circle, and drag a vertex of the parallelogram.

When using the **Hide/Show** tool:

- The pointer changes to an eraser when it is near an available object to hide.
- After pressing ENTER, the object is displayed with dotted lines until the pointer is moved away.
- To show objects previously hidden, move the pointer to the object's location. The pointer changes to a pen when it is close to a hidden object. Press ENTER to show the object.

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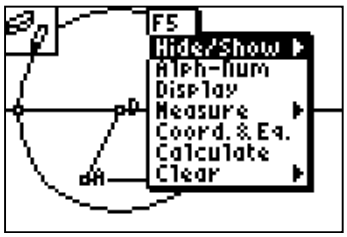
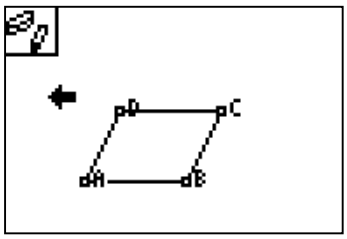
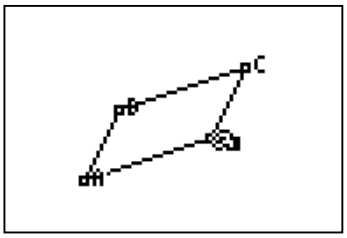
19. Press GRAPH to view the **Display Tools Menu** (**F5 Menu**), and then highlight **Hide/Show**. Press ENTER.



20. Use the **Hide/Show** tool to hide the parallel line, the compass circle, and the extra intersection point. Move the cursor to the object you wish to hide, and press ENTER. When complete, press CLEAR to exit the tool.



21. Use the hand cursor to drag vertex *B* of the quadrilateral. Move the cursor to vertex *B* of the parallelogram and press ALPHA to grab it. Drag the vertex around the screen and observe the results.



Note: *Be careful to grab the vertex itself, not the label.*

Note: *The pointer changes to a hollow arrow when it is near an available object.*

Try to grab the other vertices and observe the results. When complete, press CLEAR to exit.

To prepare for the next part of the activity, save your work OR clear all objects from the screen.

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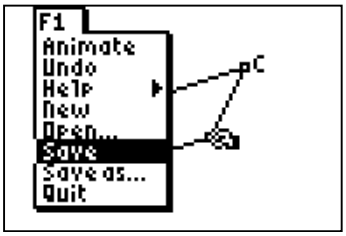
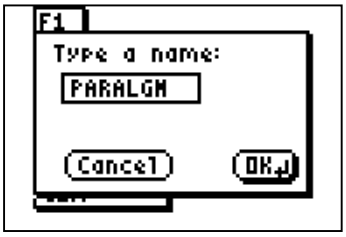
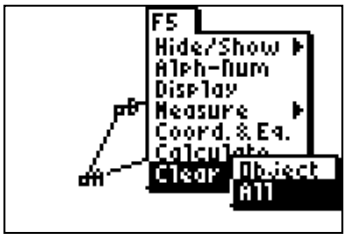
22. To save the construction, press [Y=] to view the **File Tools Menu** (**F1 Menu**), and then highlight **Save**. Type a name for the construction, and press [ENTER].





23. To clear the screen without saving, press [GRAPH] to view the **Display Tools Menu** (**F5 Menu**), and then highlight **Clear**. Press [▶] to view the **Clear Menu**. Highlight **Clear All**. Press [ENTER] to select the tool and clear all objects from the screen.

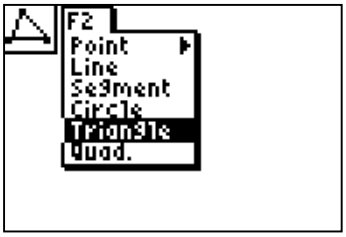


Note: *If desired, press* [Y=] *to view the* **File Tools Menu** *(***F1 Menu***), and then highlight* **Undo** *to get the objects back. Press* [ENTER] *to undo the previous action.*

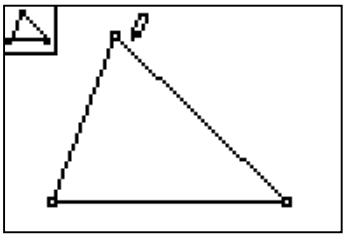
Part II: Construct an altitude, angle bisector, and median of a triangle

△ A Create a triangle and label its vertices.

1. Press [WINDOW] to view the **Drawing Tools Menu** (**F2 Menu**), and then highlight **Triangle**. Press [ENTER].



2. Move the cursor to the lower left of the screen, and press [ENTER] to anchor the first vertex of the triangle.



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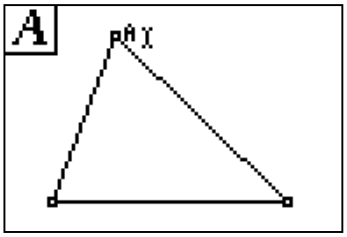
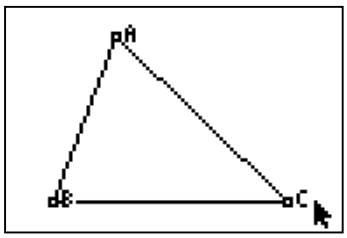
3. Move the cursor to the desired location for the second vertex, and press ENTER to anchor it. Repeat this for the third vertex.

4. Use the **Alpha-Numeric** tool (GRAPH, **F5 Menu**) to label the vertices of the triangle. Move the cursor to the vertex of the triangle highest on the screen. Label this point *A* (A is above MATH). Remember to press ENTER once to create the label and then again to complete the label.

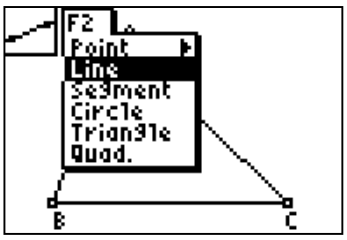


5. Repeat this procedure to label the other vertices *B* and *C* (B is above APPS, C is above PRGM). When complete, press CLEAR to exit the **Alpha-Numeric** tool.



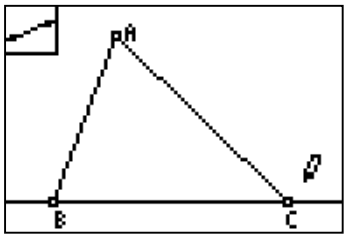
Construct a line on one side of the triangle.

6. Press WINDOW to view the **Drawing Tools Menu** (**F2 Menu**), and then highlight **Line**. Press ENTER.



7. Move the cursor to vertex *B* of the triangle, and press ENTER to anchor one point of the line there. Move the cursor to vertex *C* of the triangle, and press ENTER to anchor the second point of the line there.

   Note: *If necessary, press* ALPHA *to grab and move labels and other objects to a more convenient area.*



Construct a line through vertex *A* perpendicular to side *BC* and label the intersection point.

To use the **Perpendicular** tool, you must do the following:

- Select the point through which the perpendicular line will be drawn.
- Select the line or segment to which the new line will be perpendicular.

The order of the selection does not matter.

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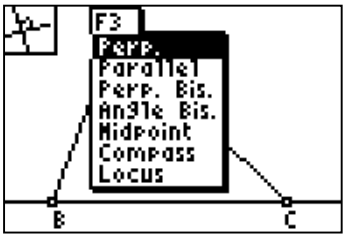
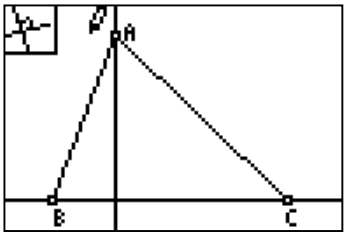
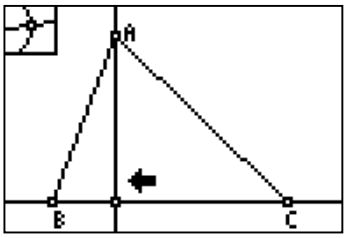
8. Press ZOOM to view the **Construction Tools Menu** (**F3 Menu**), and then highlight **Perp**. Press ENTER.



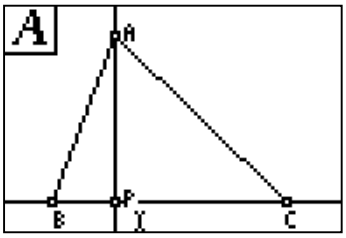
9. Move the cursor to the line containing side $\overline{BC}$ of the triangle, and press ENTER. Move the cursor to vertex *A*, and press ENTER. A line is drawn through point *A* perpendicular to the line containing side $\overline{BC}$.



10. Select the **Intersection Point** tool (WINDOW, **F2 Menu**). Move the cursor to the intersection of the perpendicular line with side *BC* of the triangle, and press ENTER to create an intersection point there.

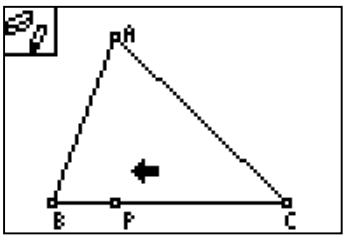


11. Use the **Alpha-Numeric** tool (GRAPH, **F5 Menu**) to label the newly created point *P* (P is above 8). Remember to press ENTER once to create the label and then again to complete the label.



Hide the lines, and construct the altitude segment.

12. Use the **Hide/Show** tool (GRAPH, **F5 Menu**) to hide the perpendicular line and the line through points *B* and *C*. Move the cursor to the object you wish to hide, and press ENTER. When complete, press CLEAR to exit the tool.



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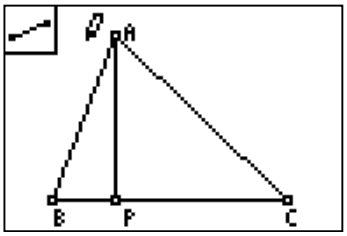
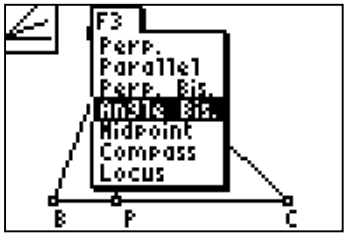
13. Use the **Segment** tool (WINDOW, **F2 Menu**) to create $\overline{AP}$ is an altitude of ΔABC. Remember to press ENTER at each desired endpoint. When complete, press CLEAR to exit the tool.

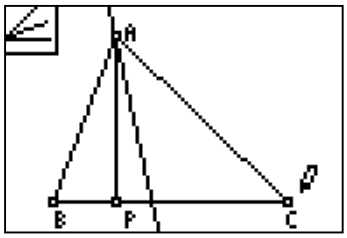


Construct the angle bisector of $\angle BAC$.

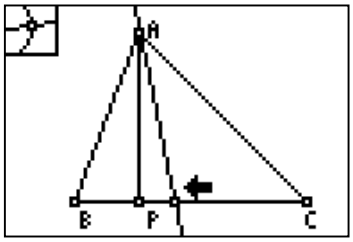
14. Press ZOOM to view the **Construction Tools Menu** (**F3 Menu**), and then highlight **Angle Bis.**. Press ENTER.



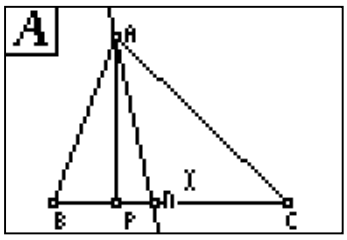
15. Move the cursor to point *B*, and press ENTER. Move the cursor to point *A*, and press ENTER. Finally, move the cursor to point *C*, and press ENTER. The angle bisector of $\angle BAC$ is created.



16. Use the **Intersection Point** tool (WINDOW, **F2 Point Menu**) to create a point where the angle bisector intersects side $\overline{BC}$ of the triangle.



17. Use the **Alpha-Numeric** tool (GRAPH, **F5 Menu**) to label the newly created point *N* (N is above LOG). Remember to press ENTER once to create the label and then again to complete the label.



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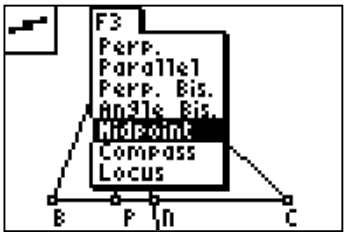
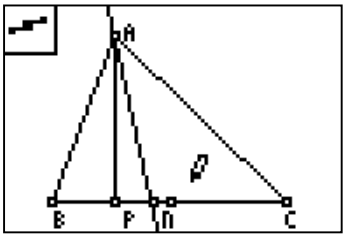
Construct the median to side $\overline{BC}$ of the triangle.

18. Press [ZOOM] to view the **Construction Tools Menu** (**F3 Menu**), and then highlight **Midpoint**. Press [ENTER].

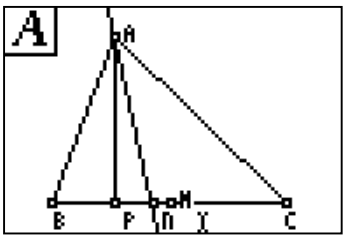


19. Move the cursor to side $\overline{BC}$ of the triangle, and press [ENTER] to create the midpoint.

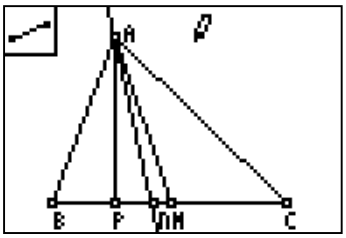


20. Use the **Alpha-Numeric** tool ([GRAPH], **F5 Menu**) to label the newly created point as *M* (M is above [÷]). Remember to press [ENTER] once to create the label and then again to complete the label.

Note: *If necessary, press* [ALPHA] *to grab and move labels and other objects to a more convenient area.*



21. Use the **Segment** tool ([WINDOW], **F2 Menu**) to create the segment $\overline{AM}$. This segment is a median of ΔABC. When complete, press [CLEAR] to exit the tool.



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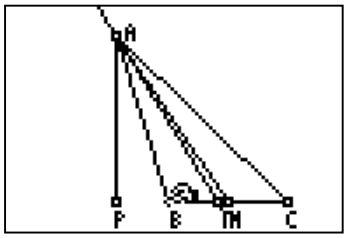
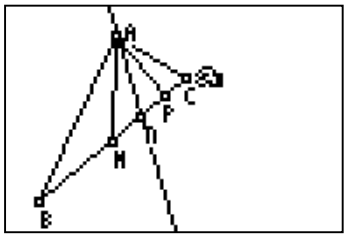
Drag a vertex of the triangle.

22. Move the cursor to the desired vertex, and press [ALPHA] to grab it. Use the cursor keys to drag the vertex around the screen, and observe what happens to the altitude $\overline{AP}$, angle bisector $\overline{AN}$ and median $\overline{AM}$. Be sure to create different types of triangles (acute, right, and obtuse).



Note: *Be careful to grab the vertex itself, not the labels A, B, or C.*



Note: *The pointer changes to a hollow arrow when it is near an available object.*

When complete, press [CLEAR] to exit the tool.

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Data Collection and Analysis

Name _____

Date _____

Questions and Conjectures

Part I

1. How is the **Compass** tool like a real compass?

_____

_____

_____

2. What happened when you tried to grab the vertices of the parallelogram in step **21** of **Part I**? Were they all available to drag?

_____

_____

_____

3. **Extension:** Use the **Slope** tool (GRAPH, **F5 Measure Menu**) to find the slopes of the sides of the parallelogram. Drag a vertex of the parallelogram. Observe and explain the results.

_____

_____

_____

Part II

4. What do you notice about the locations of the altitude, angle bisector, and median of a triangle? Can any of these go outside the triangle or on one side of a triangle? Does the location depend on the type of triangle created (acute, right, obtuse)?

_____

_____

_____

5. Are the altitude, angle bisector, and median of a triangle always in a particular order (does one of them stay in between the other two no matter what type of triangle is formed)?

_____

_____

_____

_____

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

_____

_____

_____

7. **Extension:** Use the **Triangle** tool (WINDOW, **F2 Menu**) to create ΔBAM and ΔCAM (the triangles created by the median $\overline{AM}$. Then use the **Area** tool (GRAPH, **F5 Measure Menu**) to measure the areas of these triangles. Why do you get this result?

_____

_____

_____

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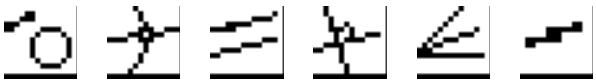
Teacher Notes

Activity 1

Objective

- To Use Cabri® Jr. tools to perform simple constructions

Cabri® Jr. Tools



Simple Constructions

Construction Notes

The **Compass** tool can be used in two ways:

- Select a point-to-point distance. Press ENTER to select the first point of the distance and press ENTER again to select the second point of the distance. Then press ENTER a final time to select the center point of the new compass circle.
- Select a segment. Press ENTER to select the segment as the distance to be copied. Press ENTER a second time to select the center point of the new compass circle.

Answers to Questions and Conjectures

Part I

1. How is the **Compass** tool like a real compass?

The **Compass** tool acts like a real compass because it "marks" the center and the radius of the original measurement, then transfers that measurement to a new center.

2. What happened when you tried to grab the vertices of the parallelogram in step **21** of **Part I**? Were they all available to drag?

Only points *A*, *B*, and *D* are available to drag as independent points. Point *C* is a constructed point, and its location is dependent on the locations of the other three vertices.

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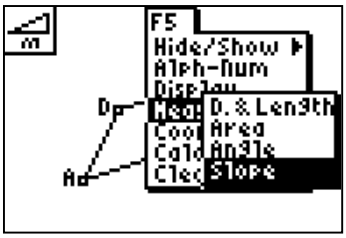
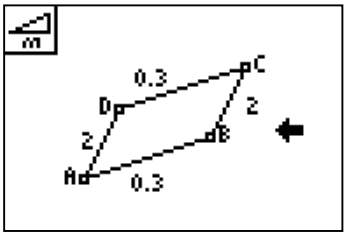
3. **Extension:** Use the **Slope** tool (GRAPH, **F5 Measure Menu**) to find the slopes of the sides of the parallelogram. Drag a vertex of the parallelogram. Observe and explain the results.

   The slopes of opposite sides will be equal. This confirms that the quadrilateral is a parallelogram.





Part II

4. What do you notice about the locations of the altitude, angle bisector, and median of a triangle? Can any of these go outside the triangle or on one side of a triangle? Does the location depend on the type of triangle created (acute, right, obtuse)?

   The angle bisector and median will always stay inside the triangle. The altitude will go outside of the triangle when the triangle is obtuse and the altitude is drawn from one of the acute angle vertices. The altitude will be on one side of the triangle when the triangle is right and the altitude is drawn from one of the acute angle vertices.

5. Are the altitude, angle bisector, and median of a triangle always in a particular order (does one of them stay in between the other two no matter what type of triangle is formed)?

   The angle bisector is always between the median and the altitude.

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

   The segments will be the same segment when they are constructed in an isosceles triangle from the vertex angle (the non-congruent angle) to the base. They will also be the same segment if drawn from any vertex of an equilateral triangle.

7. **Extension:** Use the **Triangle** tool (WINDOW, **F2 Menu**) to create ΔBAM and ΔCAM (the triangles created by the median $\overline{AM}$. Then use the **Area** tool (GRAPH, **F5 Measure Menu**) to measure the areas of these triangles. Why do you get this result?

   The **Area** tool can measure areas of closed figures only. Therefore, new triangles must be created because the median $\overline{AM}$ does not create a closed figure by itself.

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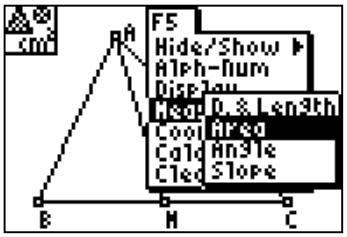
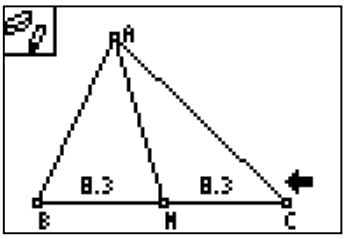
The areas of the two triangles created by the median are equal. This is because the bases of the new triangles are equal; each is half of the base of the original triangle. The altitudes (heights) of the new triangles are also equal. The area of each new triangle is $\frac{1}{2}bh$ where *b* and *h* are the base and altitude (height) of the original triangle.





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