Properties of Special Parallelograms

Lab Summary:
This lab consists of four activities that lead students through the construction of a parallelogram, a rectangle, a square, and a rhombus. Students then explore the shapes, making conclusions about the angles, diagonals, and sides of the shapes.

Key Words:
Parallelogram, rectangle, rhombus, square, Venn Diagram

Background Knowledge:
Students should be familiar with the basic geometry software commands. They also should understand some properties of the special parallelograms.

Learning Objectives:
Students will identify the basic properties of special parallelograms.

Materials:
Geometry software

Suggested procedure:
Split students into groups of two or three. This lab consists of four activities which could take three class periods to complete. If time is a factor, assign each group one lab and have students present their findings so that all four activities are discussed.
Properties of Parallelograms
Activity One

Team member’s names: __________________________________________________

File Name: ___________________________________________________________________

Goal: Construct a parallelogram and analyze its properties.
Investigate using Cabri:

1. Construct a point. [Use segment tool]
2. Label the point A. [Use the label tool]
3. Construct a horizontal line through point A. [Use the perpendicular line tool]
4. Label this line l. [Use the label tool]
5. Construct a different line through point A and label it m. [Use line tool]
6. Construct a point on line m and label it B. [point tool and label tool]
7. Construct a line through point B and parallel to line l. [Use parallel line tool]
8. Construct a point on line l and label it point D. [Point and label tool]
9. Construct a line through point D and parallel to line m. [Use parallel line tool]
10. Draw a point at this new intersection and label it point C. [Use the Intersection point tool]

Your figure should be similar to the following construction.

11. The defining characteristic of a parallelogram is that both pairs of opposite side are parallel. Check the opposite sides to see if they are parallel [use the parallel tool]. Is your shape a parallelogram? _________________________________________________

12. Measure the opposite sides of the parallelogram. Label these measurements and drag them to the side of the parallelogram so you can look at them later. [use the length and distance tool] What relationship do you see?
________________________________________________________________________
________________________________________________________________________

13. Measure the angles, label, and drag these measurements to the side also [use the angle measure tool]. What relationship do you see?
________________________________________________________________________
________________________________________________________________________
14. Now drag point $B$ along line $m$ to create different parallelograms. What do you notice about the side and angle measurements? Drag point $D$ along line $l$. What do you notice about the measurements?

________________________________________________________________________
________________________________________________________________________

15. Based on your findings in #12-#14, what properties have you discovered about parallelograms?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

**Extension:**

Using Cabri construct a Venn Diagram that shows the relationship of quadrilaterals and parallelograms.

An example of a Venn Diagram is shown below.

![Venn Diagram]

Extension: Beyond the properties of parallelogram, what characteristic do the following quadrilaterals have?
1. II and IV share?
2. III and IV share?
3. Explain in your own words why they share those properties?
Rectangle: A Special Parallelogram

Activity Two

Team member’s names: ____________________________________________________________

File Name: ___________________________________________________________________

Lab Goals: The previous lab you discovered the properties of a parallelogram. Now, we will take a look at some special parallelograms.

Use the following steps to create a Rectangle

1. Construct a point A [Use the point tool]
2. Construct a line through point A and label it line l. [Use the line tool]
3. Construct a line perpendicular to line l, through point A. Label this line m. [Use the perpendic tool]
4. Construct a point B on line m, but not point A [Use the point tool]
5. Construct a line through point B and parallel to line l. [Use the parallel line tool]
6. Construct a point D on line l, but not point A. [Use the point tool]
7. Construct a line through point D parallel to line m. [Use the parallel line]
8. Label the new point of intersection C [Use the point tool]
9. Now construct segments \( \overline{AB} \), \( \overline{BC} \), \( \overline{CD} \), and \( \overline{DA} \) and hide all other lines. [Segment tool and hide tool]

You should have a quadrilateral similar to the one below:
This is called a rectangle.

10. Is this quadrilateral a parallelogram? Explain. (Hint see #11 on Lab #2)

______________________________________________________________________________

______________________________________________________________________________

_______
11. Measure the length of the sides of rectangle ABCD and move to the side of the rectangle. What observations can you make about the sides of a rectangle? [Use the distance and length tool]

____________________________________________________________________________
____________________________________________________________________________

12. Measure the angles of rectangle ABCD and drag these measurements to the side for later use. Is there a relationship between these four angles? [Use the angle tool]

____________________________________________________________________________
____________________________________________________________________________

13. Drag point B along line m and drag point D along line l. What happens to the angle measure and length of the sides?

____________________________________________________________________________
____________________________________________________________________________

14. From the discoveries you made in #13, fill in the following true statements:

a.) _______________________ sides of a rectangle are congruent and parallel.
b.) The angles of a rectangle are always ____________________ angles.

Note: If students are not familiar with Cabri, press F1 on the keyboard. A help menu for each tool selected will appear on the bottom of the screen.
Square: A Special Parallelogram
Activity Three

Team member’s names: ________________________________

File name: ________________________________________

Lab Goals: Now let’s use the computer to construct a square using the regular polygon tool. Identify the special properties of a square.

1. Construct a Regular Polygon with four sides [Use the regular polygon tool]
   A regular polygon with four sides is also called a square.

2. Label the sides of the Square O, P, Q, and R moving clockwise around the square. [Label tool]

3. Measure the sides of the square. Record below:

   \[\overline{OP} = \quad \overline{QR} = \quad \overline{PQ} = \quad \overline{RO} = \quad\]

4. Measure angles of the square. Record below:

   \[m\angle O = \quad m\angle Q = \quad m\angle P = \quad m\angle R = \quad\]

5. What observations can be made about the angles and sides of a square?

   ___________________________________________________________________
   ___________________________________________________________________

6. Based on the defining characteristic of a rectangle, do you think a square is a rectangle (Hint look at the angles)? Why or why not?

   ___________________________________________________________________
   ___________________________________________________________________

Note: If students are not familiar with Cabri, press F1 on the keyboard. A help menu for each tool selected will appear on the bottom of the screen.
Extension:

Using Cabri, construct a Venn Diagram that shows the relationship of quadrilaterals, parallelograms, rectangles, and squares. Indicate what each circle represents. Discuss in a paragraph what the diagram shows about the relationship between the three shapes.

An example of a Venn Diagram is shown below.
Rhombus: A Special Parallelogram
Activity Four

Team member’s names: __________________________________________________

File name: ______________________________________________________________

Goal: Construct a rhombus and analyze its properties.

Investigate using Cabri:
16. Draw two perpendicular lines through. [Use the perpendicular tool]
17. Label these line $m$ and $n$.
18. Construct a point on line $m$. Label this point $A$.
19. Construct a point on line $n$ and label it point $B$. [Use segment tool]
20. Construct segment $AB$. [Use the point tool]
21. Reflect segment $AB$ about line $n$. [Use the reflection tool]
22. Label this new endpoint $C$. [Use the label tool]
23. Reflect the segment $BC$ about line $m$. [Use the reflection tool]
24. Label this new point $D$. [Use the label tool]
25. Reflect this segment $CD$ about line $n$. [Use the reflect tool]
26. Hide all lines except segments $AB$, $BC$, $CD$, and $AD$. [Use the hide tool]

Your figure should be similar to the following construction.

Remember that the defining characteristic of a parallelogram is that both pairs of opposite side are parallel.

26. Check the opposite sides to see if they are parallel. [use the parallel tool].
   Is your shape a parallelogram? Why or Why not?
   ____________________________________________________________
Definition: A rhombus is a parallelogram with two consecutive congruent sides.

12. Find the measurement of the sides and drag to the side. [use the length and distance tool]
   Is your shape a rhombus? Why or why not?

13. Drag point B and notice the side measurements. Is the shape still a rhombus? Why or why not?

14. Is the shape still a parallelogram? Why or why not? (hint- remember the defining characteristic of a parallelogram)?

15. Fill in the following statements using the words “rhombus and parallelogram” for each one:
   a.) A __________________ is always a __________________.
   b.) But, a __________________ is not always a ___________________.

16. Now, have the computer construct a square. Remember that a square is a regular polygon with four sides. [Use the regular polygon tool]

Your square should look like the following:

17. Now, using your discoveries above, determine and explain whether or not a square is a rhombus.
18. You have already discovered that a square is a rectangle. Therefore, can a rectangle be a rhombus? When?

_________________________________________________________________________
_________________________________________________________________________

**Extension:**

Using Cabri construct a Venn Diagram that shows the relationship of quadrilaterals and parallelograms, rectangles, squares and rhombuses. An example of a Venn Diagram is shown below.

![Venn Diagram](image-url)