**Standards Targeted:**

1. G-CO.11: Prove theorems about parallelograms.

**Aspect(s) of Rigor Targeted:** Conceptual Understanding, Application

**Mathematical Practices Targeted:**

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.

**Background Knowledge of Students:** Students know the properties of parallelograms, how to prove that a quadrilateral is a parallelogram, and have a working knowledge of rectangles from previous math classes. I am expecting that they know that a rectangle has four right angles and that opposite sides are congruent. Students also have competency in completing proofs.

**Core Action Indicators well-illustrated by this lesson:**

2B, 2C, 2D, 2E

**Essential Question/Objective:** Can you prove properties of rectangles, and compare and contrast the properties of rectangles and parallelograms?

* **Announcements/Pledge/Attendance (9:40 – 9:50)**
* **Opening Activity (9:50 – 9:53):** *Consider the following description of a rectangle.*If a quad is a rectangle, then it has four right angles. *Create a list of things that you know about rectangles. Groups report out.*
* **Opening Activity (9:53 – 10:00):** Are the following statements Sometimes, Always, or Never true? Work with your groups to come up with specific examples or counter-examples to justify your conclusion. “If a quadrilateral is a parallelogram, then it is a rectangle.” “If a quadrilateral is a rectangle, then it is a parallelogram.” *Teacher will monitor student conversations and choose groups to put up their solutions on the board. The class will quickly evaluate the results and come to consensus.* ***Modify the definition of a rectangle:*** **If a quad is a rectangle, then it is a parallelogram with four right angles.**
* **Properties of Rectangles (10:00 – 10:20).** *In groups, students will complete proofs about various properties of quadrilaterals. Teacher will monitor the results and will choose students to display the proofs on the board. Students will then work in groups to complete a document about the properties of rectangles. The class will then come together and discuss/edit the results.* ***Emphasize diagonals.***
* **Solving Problems Involving the Properties of Rectangles (10:20 – 10:40).** *Students will work individually, and then in groups on four problems involving the properties of rectangles (and parallelograms). After 10 minutes, they will switch papers with another group, examine the results, provide feedback, and then switch back. The class will go through the results together.*
* **Ways to prove that a quad is a rectangle (10:40 – 11:45).**
	1. If a parallelogram has one right angle, then it is a rectangle.
	2. If a parallelogram has diagonals that are congruent, then it is a rectangle.
* **Coordinate Proof with Rectangles (10:45 – 11:00).** Given four ordered pairs, students will individually use coordinate geometry in order to prove whether or not a shape is a rectangle. They will then compare within groups. Teacher will monitor, and will choose students with various methods to put up the solutions on the board.
* **Summary (11:00 – 11:05)**. Teacher will use choral response with the class in order to summarize the key points of the lesson.
* **Correct HW (11:05 – 11:25).** Teacher and students will generate a list of questions from the HW assignments. Students will volunteer to provide (and explain) the solutions.

Proof #1: Prove the following property about rectangles: “If a quadrilateral is a rectangle, then it has congruent diagonals.”

**Given:** Rectangle $ABCD$

A

 B

C

D

**Prove:** $\overbar{AC}≅\overbar{BD}$.

 **Statement Reason**

Proof #2: Prove the following property: If a quadrilateral is a rectangle, then consecutive angles are congruent.

A

 B

C

D

**Given:** Rectangle $ABCD$ $ $

**Prove:** $∠A ≅∠B$

 **Statement Reason**

**Properties of Quadrilaterals**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Parallelogram | Rectangle | Rhombus | Square | Trapezoid | Isosceles Trapezoid | Kite |
| Sides | Both pairs of opposite sides are congruent. |  |  |  |  |  |  |  |
| Both pairs of opposite sides are parallel. |  |  |  |  |  |  |  |
| Both pairs of consecutive sides are congruent. |  |  |  |  |  |  |  |
| Exactly **(only)** one pair of opposite sides are parallel. |  |  |  |  |  |  |  |
| Exactly **(only)** one pair of opposite sides are congruent. |  |  |  |  |  |  |  |
| All four sides are congruent. |  |  |  |  |  |  |  |
| Angles | Both pairs of opposite angles are congruent. |  |  |  |  |  |  |  |
| All pairs of consecutive angles are supplementary. |  |  |  |  |  |  |  |
| Upper base angles are congruent; lower base angles are congruent. |  |  |  |  |  |  |  |
| Upper and lower base angles are supplementary. |  |  |  |  |  |  |  |
| All four angles are congruent. |  |  |  |  |  |  |  |
| Diagonals | Diagonals bisect the angles. |  |  |  |  |  |  |  |
| Diagonals bisect each other. |  |  |  |  |  |  |  |
| Diagonals are perpendicular. |  |  |  |  |  |  |  |
| One diagonal bisects the other diagonal. |  |  |  |  |  |  |  |
| Diagonals are congruent. |  |  |  |  |  |  |  |

*Key to proofs:*

Proof #1: Prove the following property about rectangles: “If a quadrilateral is a rectangle, then it has congruent diagonals.”

**Given:** Rectangle $ABCD$

A

 B

C

D

**Prove:** $\overbar{AC}≅\overbar{BD}$.

 **Statement Reason**

 1) Rectangle $ABCD$ 1) Given

 2) ABCD is a parallelogram; $∠B$ and $∠C $rt <s 2) If a quad is a rect, then it is a parallelogram

 with four rt angles.

 3) $∠B$ $≅$ $∠C$ 3) If rt <s, then congruent.

 4) $\overbar{AB}≅\overbar{DC}$. 4) If parallelogram, then opp sides congruent.

 5) $\overbar{BC}≅\overbar{BC}$. 5) reflexive

 6) $∆ABC≅∆DCB$ 6) SAS (4, 3, 5)

 7) $\overbar{AC}≅\overbar{BD}$. 7) CPCTC

Proof #2: Prove the following property: If a quadrilateral is a rectangle, then consecutive angles are congruent.

A

 B

C

D

**Given:** Rectangle $ABCD$ $ $

**Prove:** $∠B ≅∠C$

 **Statement Reason**

1) Rectangle $ABCD$ 1) Given

 2) ABCD is a parallelogram; $∠B$ and $∠C $rt <s 2) If a quad is a rect, then it is a parallelogram

 with four rt angles.

 3) $∠B ≅∠C$ 3) If right angles, then congruent.