

TITLE OF LESSON

Geometry Unit 1 Lesson 39 – Geometric Concepts: Properties of Parallelograms
Prove it! What's on the outside? What's on the inside? Of Geometry

TIME ESTIMATE FOR THIS LESSON

One class period

ALIGNMENT WITH STANDARDS

California – Geometry

10.0 Students compute areas of polygons, including rectangles, scalene triangles, equilateral triangles, rhombi, parallelograms, and trapezoids.

MATERIALS

None

LESSON OBJECTIVES

- To demonstrate a number of proofs related to parallelograms
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FOCUS AND MOTIVATE STUDENTS

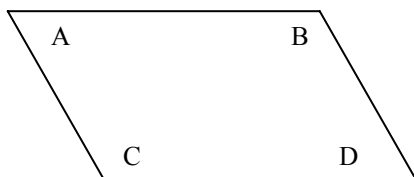
- 1) Homework Check – Stamp/initial complete homework assignments. Pass back graded work and have students place in the appropriate sections of their binders.
- 2) [Agenda](#) – Have students copy the agenda.
- 3) Homework Review – (5 minutes) Review homework from Lesson 38. Recall the homework assignment was:

Find 10 examples of shapes in the real world that conform to the shapes we looked at today. Extra points will be given for anyone who finds a rhombus or a trapezoid. Make a drawing, take a picture, cut it out of a magazine or write a description.

Have each student describe or show two of his or her examples to the class. Ask each if they have found an example of a rhombus or a trapezoid. Collect homework.

ACTIVITIES – INDIVIDUAL AND GROUP

1. Parallelograms: Theorem & Proof – (5 minutes) Draw the parallelogram below on the board and have students copy it into their binders in the *theorems and postulates* section. Under it, they should write the theorem.



Theorem: *Consecutive pairs of angles in a parallelogram are supplementary.* Ask students if they can identify the consecutive angles in this parallelogram. In this case the consecutive angles are (A and B) and (B and D) and (D and C) and (C and A). Ask students what it means to say that two angles are supplementary. They should be able to come up with the fact that this means that their measures add to 180° . If a student can prove this, let him. Otherwise, walk through the proof below with them.

So for example, in the parallelogram above, let us prove that (A and C) are supplementary.

Prove: $\angle A$ and $\angle C$ are supplementary angles

Statement	Reason
1. AB is parallel to CD.	1. Definition of a parallelogram.
2. AC can be defined as a transversal that cuts two parallel lines.	2. Define it as such (i.e., definition).
3. $\angle A$ and $\angle C$ are supplementary.	3. Consecutive interior angles formed by a transversal cutting parallel lines are supplementary.

4. Parallelograms: Theorem & Proof – (5 minutes) Here’s another proof:

Theorem: *Opposite angles of a parallelogram are congruent.*

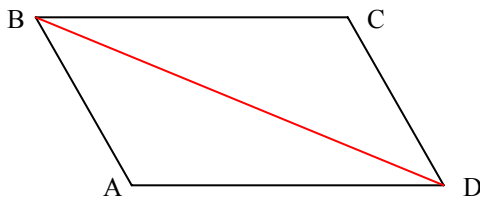
For this proof let us look at angles A and D, in the parallelogram above.

Prove: $m\angle A \cong m\angle D$

Statement	Reason
1. $\angle A$ and $\angle C$ are supplementary	1. Consecutive pairs of angles in a parallelogram are supplementary.
2. $m\angle A + m\angle C = 180^\circ$	2. Definition of supplementary.
3. $\angle C$ and $\angle D$ are supplementary	3. Consecutive pairs of angles in a parallelogram are supplementary.
4. $m\angle C + m\angle D = 180^\circ$	4. Definition of supplementary.
5. $m\angle A + m\angle C \cong m\angle C + m\angle D$	5. Substitute Statement 2 into Statement 4.
6. $m\angle C \cong m\angle C$	6. Reflexive property
7. $m\angle A \cong m\angle D$	7. Subtraction property – Statement 5 minus Statement 6.

5. Parallelograms: Theorem & Proof – (5 minutes) Another proof:

Theorem: *In a parallelogram a diagonal separates the parallelogram into two congruent triangles.*



Prove: $\triangle BDA \cong \triangle BDC$

Statement	Reason
1. $BD \cong BD$	1. Reflexive
2. $\angle ABD \cong \angle CDB$	2. Alternate interior angles of two parallel lines (BC and AD) cut by a transversal (BD) are congruent.
3. $\angle CBD \cong \angle ADB$	3. Alternate interior angles of two parallel lines (BC and AD) cut by a transversal (BD) are congruent.
4. $\triangle BDA \cong \triangle BDC$	4. ASA

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Remember this?!

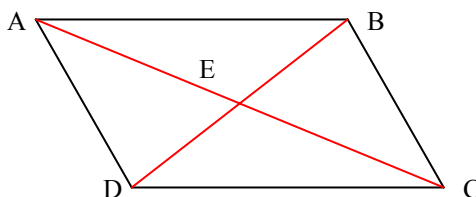
6. Parallelograms: Theorem & Proof – (10 minutes)

Theorem: *Opposite sides of a parallelogram are congruent*

This one follows directly from the previous proof. Ask a student to demonstrate. Try to elicit a simple statement that this follows directly. Someone might say something like “Of course they do.” If someone says this try to get him to explain. Since we have shown that $\triangle BDA \cong \triangle BDC$ then it must be true that $BA = CD$ and $BC = AD$ because corresponding sides of congruent triangles are congruent.

7. Pair/Group Work – (20 minutes) Have students work through this one in pairs or small groups. Most of this they’ve done or at least seen before. As they are working on this proof, post the other proofs (in the *Homework* section) for them to work on in their groups as soon as they finish this proof. These additional proofs are basically taken from the proofs you’ve done in class today, so the students should not have trouble with them. For instance for #1 above there are four consecutive pairs of angles. You did the proof for one of the pairs. Any proof they do not finish, they should complete for homework.

Theorem: *The diagonals of a parallelogram bisect each other.*



Statement	Reason
1. $AB \cong DC$	1. Opposite sides of a parallelogram are equal.
2. $\angle EAB \cong \angle ECD$	2. Alternate interior angles of parallel lines cut by a transversal are equal.
3. $\angle EDC \cong \angle EBA$	3. Alternate interior angles of parallel lines cut by a transversal are equal.
4. $\triangle EAB \cong \triangle ECD$	4. ASA
5. $AE \cong EC$ (therefore bisected)	5. Corresponding sides of congruent triangles are congruent.
6. $BE \cong ED$ (therefore bisected)	6. Corresponding sides of congruent triangles are congruent.
7. The diagonals of a parallelogram bisect each other	7. Definition of bisect.

HOMEWORK

- 1) Finish any of the proofs not completed in part 5 above.
- 2) Using the parallelogram from the first proof you did in class today:
Prove: $\angle D$ and $\angle C$ are supplementary angles
Prove: $m\angle B \cong m\angle C$
- 2) Using the second parallelogram:
Prove: $\triangle CDA \cong \triangle CDB$

GROUP ROLES

- Recorder – When the students work in groups, every student must act as recorder.
Facilitator – It is your responsibility to make sure your group stays focused. As you group students, assign or have one student choose to be facilitator.

DOCUMENTATION FOR PORTFOLIO

None