PROPERTIES OF QUADRILATERALS

A QUADRILATERAL CLASSIFICATION

A.1 CONSTRUCTING QUADRILATERALS WITH A RULER AND SET SQUARE

Ex 1: Construct a square $ABCD$ with side length $AB = 3$ cm using a ruler and a set square on paper.

Answer: To construct square $ABCD$ with side length $AB = 3$ cm:

1. Draw segment $AB = 3$ cm using a ruler.

2. Place the set square at point A with one edge along AB and the other edge vertical. Draw a line through A perpendicular to AB. Measure 3 cm along this line from A to mark point D.

3. Place the set square at point B with one edge along AB and the other edge vertical. Draw a line through B perpendicular to AB. Measure 3 cm along this line from B to mark point C.

4. Connect points D and C using the ruler. Verify that $DC = 3$ cm and is parallel to AB, forming square $ABCD$.

5. Check that all sides (AB, BC, CD, DA) are 3 cm and all angles are 90° using the set square.

The resulting square is shown below:
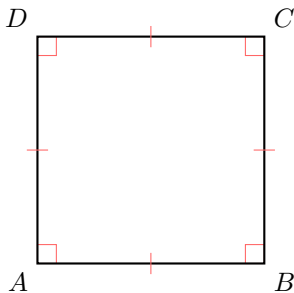
Ex 2: Construct a rectangle $ABCD$ with side lengths $AB = 4$ cm and $AD = 3$ cm using a ruler and a set square on paper.

Answer: To construct rectangle $ABCD$ with side lengths $AB = 4$ cm and $AD = 3$ cm:

1. Draw segment $AB = 4$ cm using a ruler.

2. Place the set square at point A with one edge along AB and the other edge vertical. Draw a line through A perpendicular to AB. Measure 3 cm along this line from A to mark point D.

3. Place the set square at point B with one edge along AB and the other edge vertical. Draw a line through B perpendicular to AB. Measure 3 cm along this line from B to mark point C.

4. Connect points D and C using the ruler. Verify that $BC = 3$ cm, $DC = 4$ cm, and DC is parallel to AB, forming rectangle $ABCD$.

5. Check that opposite sides ($AB = DC = 4$ cm, $AD = BC = 3$ cm) are equal, parallel, and all angles are 90° using the set square.

The resulting rectangle is shown below:
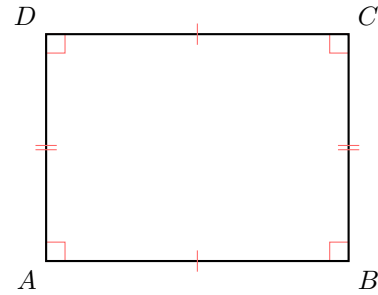
Ex 3: Construct a square $ABCD$ with diagonal length $AC = 3$ cm using a ruler and a set square on paper.

Answer: To construct square $ABCD$ with diagonal length $AC = 3$ cm:

1. Draw segment $AC = 3$ cm using a ruler, labeling points A and C.

2. Find the midpoint O of AC by measuring 1.5 cm from A (or C) along AC using the ruler.

3. Place the set square at point O with one edge along AC and the other edge vertical. Draw a line through O perpendicular to AC, extending in both directions. Measure 1.5 cm along this line in both directions from O to mark points B and D (as the distance from the center to each vertex is half the diagonal).

4. Connect points A, B, C, and D in order (A to B, B to C, C to D, D to A) using the ruler to form quadrilateral $ABCD$.
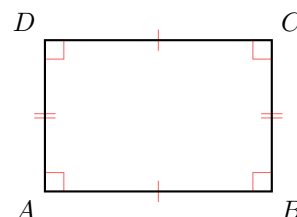
The resulting square is shown below:
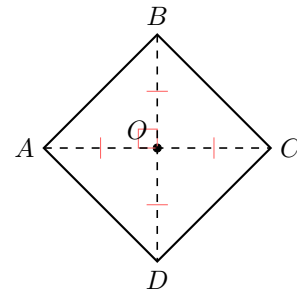
B PROPERTIES

B.1 CLASSIFYING QUADRILATERALS

MCQ 4: Classify the quadrilateral.

Choose all answers that apply:
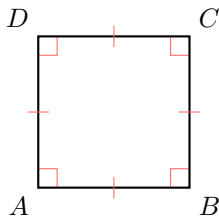
☒ Parallelogram

☒ Rhombus

☐ Rectangle

Answer: The quadrilateral $ABCD$ has four right angles, making it a rectangle. A rectangle has opposite sides parallel and equal, so it is also a parallelogram. However, it does not have four equal sides, so it is not a rhombus or a square.
Therefore, the quadrilateral is a parallelogram and a rectangle.

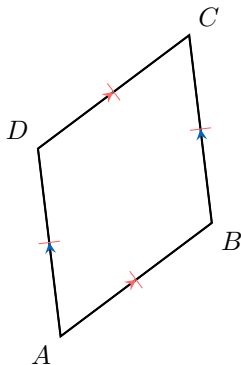**MCQ 5:** A square has four right angles.

☒ True

☐ False

Answer: The statement is true. A square has four right angles (90°).

MCQ 6: The opposite sides of a rhombus are parallel.
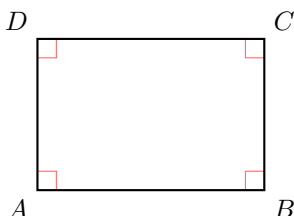
☒ True

☐ False

Answer: The statement is true. A rhombus is a parallelogram with all sides equal, and by definition, a parallelogram has opposite sides parallel.

MCQ 7: The adjacent sides of a rectangle are parallel.
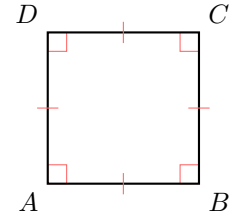
☐ True

☒ False

Answer: The statement is false. In a rectangle, adjacent sides are perpendicular, not parallel, while opposite sides are parallel and equal in length.

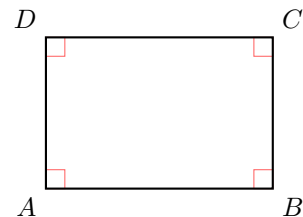**MCQ 8:** A square is a special type of rectangle.

☒ True

☐ False

Answer: The statement is true. A square has four right angles and equal sides, making it a rectangle with the additional property of equal side lengths.

MCQ 9: A rectangle is a special type of square.

☐ True

☒ False

Answer: The statement is false. A rectangle has four right angles, but its adjacent sides may have different lengths. A square has four right angles and all sides equal, so a rectangle is not necessarily a square.

MCQ 10: A rectangle is a special type of parallelogram.
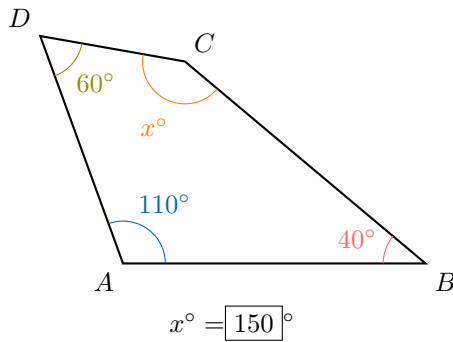
☒ True

☐ False

Answer: The statement is true. A rectangle has opposite sides parallel and equal, making it a parallelogram with the additional property of four right angles.
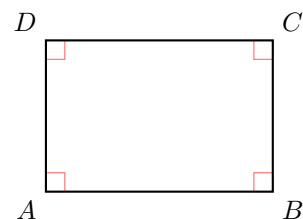
C ANGLES

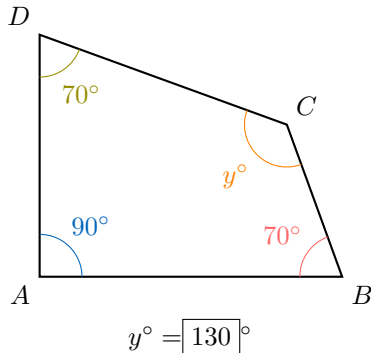### C.1 FINDING AN UNKNOWN ANGLE

Ex 11: Find the unknown angle in the quadrilateral below:

$$x° = \boxed{150}°$$

Answer: The sum of the angles of a quadrilateral is 360°. Given angles 40°, 60°, and 110°:

$$x° + 40° + 60° + 110° = 360°$$
$$x° + 210° = 360°$$
$$x° = 360° - 210°$$
$$x° = 150°$$

Ex 12: Find the unknown angle in the quadrilateral below:

$$y° = \boxed{130}°$$

Answer: The sum of the angles of a quadrilateral is 360°. Given angles 70°, 70°, and 90°:

$$y° + 70° + 70° + 90° = 360°$$
$$y° + 230° = 360°$$
$$y° = 360° - 230°$$
$$y° = 130°$$

Ex 13: Find the unknown angle in the quadrilateral below:
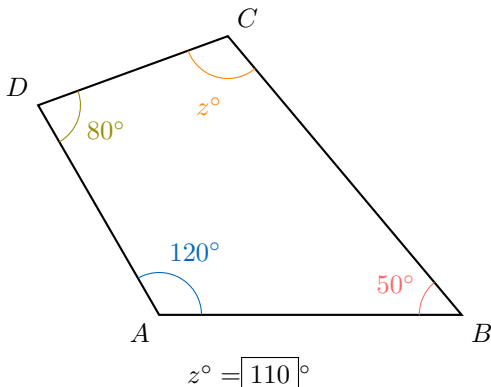
$$z° = \boxed{110}°$$

Answer: The sum of the angles of a quadrilateral is 360°. Given angles 50°, 80°, and 120°:

$$z° + 50° + 80° + 120° = 360°$$
$$z° + 250° = 360°$$
$$z° = 360° - 250°$$
$$z° = 110°$$

Ex 14: Find the unknown angle in the quadrilateral below:

$$a° = \boxed{80}°$$
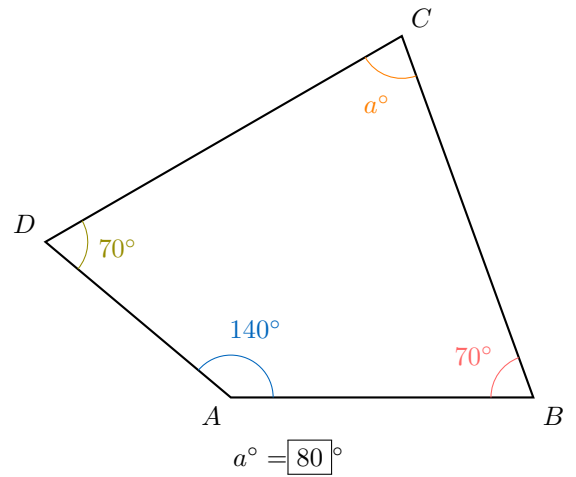
Answer: The sum of the angles of a quadrilateral is 360°. Given angles 70°, 70°, and 140°:

$$a° + 70° + 70° + 140° = 360°$$
$$a° + 280° = 360°$$
$$a° = 360° - 280°$$
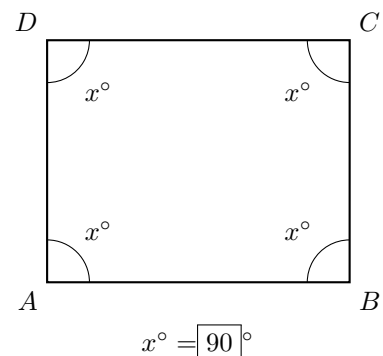$$a° = 80°$$

C.2 FINDING AN UNKNOWN ANGLE

Ex 15: Find the unknown angles in the quadrilateral below:

$$x° = \boxed{70}°$$
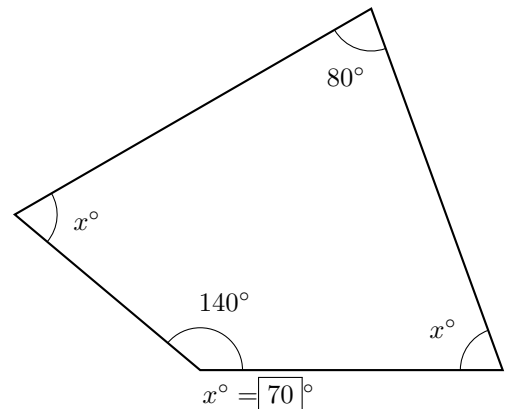
Answer: The sum of the angles of a quadrilateral is 360°. Given angles $x°$, $x°$, 80°, and 140°:

$$x° + x° + 80° + 140° = 360°$$
$$2x° + 220° = 360°$$
$$2x° = 360° - 220°$$
$$2x° = 140°$$
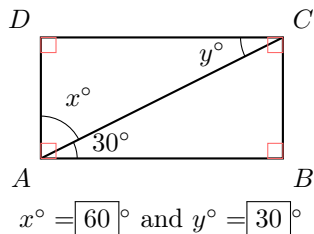$$x° = 140° \div 2$$
$$x° = 70°$$

Ex 16: Find the unknown angles in the quadrilateral below:

$$x° = \boxed{90}°$$

Answer: The sum of the angles of a quadrilateral is 360°. Given all angles are $x°$:

$$x° + x° + x° + x° = 360°$$
$$4x° = 360°$$
$$x° = 360° \div 4$$
$$x° = 90°$$

Ex 17: $ABCD$ is a rectangle. Find the unknown angles in the triangle below:

$$x° = \boxed{60}° \text{ and } y° = \boxed{30}°$$

Answer: In rectangle $ABCD$, all angles are 90°. Consider $\angle BAD = 90°$:

$$x° + 30° = 90°$$
$$x° = 90° - 30°$$
$$x° = 60°$$

In $\triangle ADC$, the sum of angles is 180°:

$$x° + 90° + y° = 180°$$
$$60° + 90° + y° = 180°$$
$$150° + y° = 180°$$
$$y° = 180° - 150°$$
$$y° = 30°$$

Ex 18: $ABCD$ is a parallelogram. Find the unknown angle in the quadrilateral below:

$$x° = \boxed{130}°$$
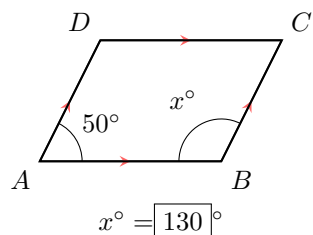
Answer: In parallelogram $ABCD$, opposite angles are equal: $\angle BAD = \angle BCD = 50°$, and $\angle ABC = \angle ADC = x°$. The sum of the angles is 360°:

$$50° + x° + 50° + x° = 360°$$
$$2x° + 100° = 360°$$
$$2x° = 360° - 100°$$
$$2x° = 260°$$
$$x° = 260° \div 2$$
$$x° = 130°$$