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Fundamental Facts

Understanding basic geometric concepts is essential for constructions. Key facts include:

- **Centre of a Circle:** The point from which all points on the circle are equidistant.
- **Quadrilateral:** Any four-sided figure.
- **Angle Construction:** Angles can be constructed using a protractor; some angles can also be constructed using a compass and scale.
- **Perpendicular Bisector:** A line that divides a given line segment into two equal parts at 90° .

Concept Explanation

These facts form the foundation for geometric constructions involving circles, lines, and angles.

Practice Set

- Construct a perpendicular bisector of a given line segment.
- Identify the centre of a given circle.
- Classify given quadrilaterals.

Answer Key

- Perpendicular bisector divides the segment into two equal parts at right angles.
- Centre is the point equidistant from all points on the circle.
- Quadrilaterals include squares, rectangles, rhombus, trapezium, etc.

Quick Reference

- Centre: equidistant point in circle.
- Quadrilateral: 4-sided polygon.
- Perpendicular bisector: divides segment equally at 90°.

Glossary

- **Centre:** Point equidistant from circle points.
- **Quadrilateral:** Polygon with four sides.
- **Perpendicular Bisector:** Line dividing segment into equal halves at right angle.

Introduction to Circle Construction

Concept Explanation: A circle is defined by its centre and radius. The radius is the distance from the centre to any point on the circle.

Formula Derivation

Radius r is constant for all points on the circle:

$$r = \text{distance}(\text{centre, any point on circle})$$

Worked Illustration

Using a compass, set the radius length on a ruler, fix the compass point at the centre, and rotate to draw the circle.

Solved Example

Draw a circle with centre P and radius 5 cm:

1. Place compass point at zero on ruler.
2. Open compass to 5 cm.
3. Fix compass point at P on paper.
4. Rotate compass to draw circle.

Practice Set

- Draw a circle with radius 3 cm.
- Construct two circles with centres 6 cm apart and radius 4 cm each.
- Find the radius of a circle given diameter 10 cm.

Answer Key

- Radius is half the diameter.
- Use compass set to radius length for drawing.

Quick Reference

- Radius r is constant distance from centre.
- Circle drawn by compass with fixed radius.

Glossary

- **Radius:** Distance from centre to circle point.
- **Compass:** Tool to draw arcs and circles.

Squares and Rectangles

Concept Explanation: Squares and rectangles are quadrilaterals with specific properties.

- **Rectangle:** Opposite sides equal and all angles 90° .
- **Square:** All sides equal and all angles 90° .
- **Rhombus:** All sides equal but angles not necessarily 90° .

Formula Derivation

For rectangle ABCD:

$$AB = CD, \quad BC = AD, \quad \angle A = \angle B = \angle C = \angle D = 90^\circ$$

For square ABCD:

$$AB = BC = CD = DA, \quad \angle A = \angle B = \angle C = \angle D = 90^\circ$$

Solved Example

Identify if PQSR is a valid name for a square with vertices S, P, R, Q:

Vertices must be named in order either clockwise or anticlockwise. PQSR is not valid as it does not follow the sequence.

Practice Set

- Identify properties of given quadrilaterals.
- Prove that diagonals of a rectangle are equal.
- Show that diagonals of a rhombus bisect each other at right angles.

Answer Key

- Rectangle diagonals are equal and bisect each other.
- Rhombus diagonals are perpendicular bisectors.
- Square is a rectangle with equal sides.

Quick Reference

- Rectangle: opposite sides equal, angles 90° .
- Square: all sides equal, angles 90° .
- Rhombus: all sides equal, diagonals perpendicular.

Glossary

- **Rectangle:** Quadrilateral with right angles and equal opposite sides.
- **Square:** Rectangle with all sides equal.
- **Rhombus:** Quadrilateral with all sides equal and perpendicular diagonals.

Constructing Squares and Rectangles

Concept Explanation: Construction uses ruler, compass, and protractor to draw accurate squares and rectangles.

Constructing a Square

1. Draw base line PQ of desired length.
2. Construct perpendicular line at P using compass arcs or protractor.
3. Mark point S on perpendicular line equal to PQ.
4. With compass at Q and S, draw arcs intersecting at R.
5. Connect S to R and Q to R to complete square PQRS.

Constructing a Rectangle

1. Draw base line PQ of longer side.
2. Construct perpendicular lines at P and Q.
3. Mark points R and S on perpendiculars equal to shorter side.
4. Connect R to S and complete rectangle PQRS.

Practice Set

- Construct a square of side 5 cm.
- Construct a rectangle with sides 7 cm and 4 cm.
- Verify right angles using protractor.

Answer Key

- Use compass and ruler for accurate lengths.
- Perpendicular lines ensure right angles.
- Arcs intersection points help locate vertices.

Quick Reference

- Use compass arcs to construct perpendiculars.
- Equal sides marked with compass width.
- Connect points to complete shapes.

Glossary

- **Perpendicular:** Lines intersecting at 90° .
- **Compass Arc:** Curve drawn with compass.
- **Protractor:** Tool to measure angles.

Diagonals of Rectangles and Squares

Concept Explanation: Diagonals connect opposite corners and have special properties.

Properties

- In rectangles, diagonals are equal and bisect each other.
- In squares, diagonals are equal, bisect each other, and are perpendicular.
- In rhombus, diagonals bisect each other at right angles but are not equal.

Formula Derivation

Using Pythagoras theorem for rectangle with sides a and b :

$$\text{Diagonal} = d = \sqrt{a^2 + b^2}$$

Solved Example

For rectangle ABCD with AB = 7 cm and BC = 4 cm, diagonal AC is:

$$AC = \sqrt{7^2 + 4^2} = \sqrt{49 + 16} = \sqrt{65} \approx 8.06 \text{ cm}$$

Practice Set

- Calculate diagonal of square with side 6 cm.
- Prove diagonals of rectangle bisect each other.
- Show diagonals of rhombus are perpendicular.

Answer Key

- Diagonal of square: $d = a\sqrt{2}$
- Diagonals bisect each other by midpoint property.
- Rhombus diagonals intersect at 90° .

Quick Reference

- Diagonal length: $\sqrt{a^2 + b^2}$
- Diagonals bisect each other.
- Square diagonals perpendicular and equal.

Glossary

- **Diagonal:** Line connecting opposite vertices.
- **Bisect:** Divide into two equal parts.
- **Pythagoras Theorem:** Relation in right triangles.

Construction of Angle 60 Degrees

Concept Explanation: Constructing a 60° angle using compass and straightedge.

Step-by-Step Construction

1. Draw line segment OB.
2. With compass at O, draw arc intersecting OB at P.
3. With compass at P, draw arc intersecting previous arc at A.
4. Draw line OA; angle $\angle AOB = 60^\circ$.

Formula Derivation

Equilateral triangle properties ensure $\angle AOB = 60^\circ$ because all sides are equal.

Practice Set

- Construct 60° angle at a point.
- Construct 120° angle using 60° angle.
- Verify angle using protractor.

Answer Key

- 60° angle constructed by equilateral triangle method.
- 120° angle is supplementary to 60° .

Quick Reference

- Use compass arcs to mark equal lengths.
- Connect points to form 60° angle.

Glossary

- **Equilateral Triangle:** Triangle with all sides equal.
- **Angle:** Figure formed by two rays with common vertex.

Construction of Perpendicular Bisector

Concept Explanation: Construct a line that divides a segment into two equal parts at right angles.

Step-by-Step Construction

1. Draw line segment AB.
2. With compass width more than half AB, draw arcs from A and B intersecting above and below AB.
3. Join intersection points of arcs; this line is the perpendicular bisector.

Formula Derivation

Perpendicular bisector passes through midpoint M of AB and is perpendicular to AB.

Practice Set

- Construct perpendicular bisector of 8 cm segment.
- Verify bisector divides segment equally.
- Use bisector to find points equidistant from A and B.

Answer Key

- Bisector divides segment into two 4 cm parts.

- Points on bisector are equidistant from A and B.

Quick Reference

- Use compass arcs to find intersection points.
- Join intersections to form bisector.

Glossary

- **Bisector:** Line dividing segment into equal parts.
- **Perpendicular:** Lines intersecting at 90° .

Constructing the Diagonal of a Square

Concept Explanation: Diagonal connects opposite corners of a square.

Step-by-Step Construction

1. Construct square with side length a .
2. Identify opposite corners, e.g., A and C.
3. Draw line AC; this is the diagonal.

Formula Derivation

Diagonal length $d = a\sqrt{2}$ by Pythagoras theorem.

Practice Set

- Construct diagonal of square with side 5 cm.
- Calculate diagonal length.

Answer Key

- Diagonal length = $5 \times \sqrt{2} \approx 7.07$ cm

Quick Reference

- Diagonal connects opposite vertices.
- Length calculated by Pythagoras theorem.

Glossary

- **Diagonal:** Line connecting opposite corners.
- **Pythagoras Theorem:** $c^2 = a^2 + b^2$ in right triangles.

Constructing the Diagonal of a Rectangle

Concept Explanation: Diagonal connects opposite corners of a rectangle.

Step-by-Step Construction

1. Draw rectangle with sides a and b .
2. Identify opposite corners, e.g., A and C.
3. Draw line AC; this is the diagonal.

Formula Derivation

Diagonal length $d = \sqrt{a^2 + b^2}$ by Pythagoras theorem.

Practice Set

- Construct diagonal of rectangle 8 cm by 5 cm.
- Calculate diagonal length.

Answer Key

- Diagonal length = $\sqrt{8^2 + 5^2} = \sqrt{64 + 25} = \sqrt{89} \approx 9.43$ cm

Quick Reference

- Diagonal connects opposite vertices.
- Length calculated by Pythagoras theorem.

Glossary

- **Diagonal:** Line connecting opposite corners.
- **Pythagoras Theorem:** $c^2 = a^2 + b^2$ in right triangles.