CLASS 7 MATHS NCERT SOLUTIONS

NCERT Solutions for Class 7 Maths Chapter 14: Constructions and Tilings – Ganita Prakash Part 2

Complete NCERT Solutions for Class 7 Maths Chapter 14 "Constructions and Tilings" (Ganita Prakash Part 2), covering ruler-and-compass constructions -- perpendicular bisectors, angle bisectors, parallel lines, hexagons -- and tiling patterns.

Contents

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6.1 Geometric Constructions — Figure It Out (Page 140)

Q1. When constructing the perpendicular bisector, is it necessary to have the same radius for the arcs above and below XY? Explore this through construction, and then justify your answer.

Answer: Draw a line segment XY. Choose radii k and k’ (each slightly more than half of XY). With centres X and Y, draw arcs of radius k **above** XY, meeting at A. With centres X and Y, draw arcs of radius k’ **below** XY, meeting at B. Join AB, cutting XY at O.
Since AX = AY = k and BX = BY = k’ with AB common, ΔABX ≅ ΔABY, so ∠XAO = ∠YAO. Then in ΔAOX and ΔAOY, AX = AY, ∠XAO = ∠YAO, and OA is common, so ΔAOX ≅ ΔAOY — giving OX = OY and ∠AOX = ∠AOY. Since ∠AOX + ∠AOY = 180°, each equals 90°.
So AB is the perpendicular bisector of XY **even though k and k’ are different** — it is not necessary to use the same radius for the upper and lower arc pairs, as long as each pair (the two arcs drawn from X and from Y for that pair) uses one shared radius.

Q2. Is it necessary to construct the pairs of arcs above and below XY? Instead, can we construct both pairs of arcs on the same side of XY? Explore this through construction, and then justify your answer.

Answer: Draw XY. With centres X and Y, draw arcs of radius k above XY, meeting at A. With centres X and Y (radius k’), draw a second pair of arcs, also above XY, meeting at B. Join AB and extend it to cut XY at O.
By the same congruence argument as Q1 (ΔABX ≅ ΔABY, then ΔAOX ≅ ΔAOY), OX = OY and ∠AOX = ∠AOY = 90°.
So AB is still the perpendicular bisector of XY, **even when both arc-pairs are drawn on the same side** — it is not necessary to construct one pair above and one pair below; two intersection points on the same side work equally well, as long as A and B are distinct points.

Q3. While constructing one pair of intersecting arcs, is it necessary that we use the same radii for both of them? Explore this through construction, and then justify your answer.

Answer: Draw XY. With centres X and Y, draw arcs of *unequal* radii k ≠ k’, meeting at a point A.
Let PQ be the true perpendicular bisector of XY, and let R be any point on PQ. Since OX = OY and ∠ROX = ∠ROY = 90° with OR common, ΔROX ≅ ΔROY, so RX = RY — every point on the perpendicular bisector is equidistant from X and Y.
But here AX = k ≠ k’ = AY, so A is **not** equidistant from X and Y, meaning A cannot lie on the perpendicular bisector.
Conclusion: yes, it is necessary to use the same radius for both arcs in a single pair (one arc from X, one from Y) — using unequal radii gives a point that is not on the perpendicular bisector at all.

Q4. Recreate this design using only a ruler and compass (a square with a symmetric four-petal pattern).

Answer: Draw square ABCD. Construct the perpendicular bisectors of sides AB and BC (using the method from Q1-Q3); these meet the four sides at their midpoints P, Q, R, S. With centres P, Q, R, S, draw semicircles inside the square, each with radius equal to AP (half the side length). This produces a symmetric four-lobed "flower" pattern — colour the outline as desired.

Figure It Out (Page 142): The Rope Method

Q1. Justify why AB is the perpendicular bisector of line XY, where XAY and XBY are two positions of a taut rope of fixed length.

Answer: Since A and B are both midpoints of a rope of the same length stretched between X and Y, AX = AY and BX = BY.
In ΔAXB and ΔAYB: AX = AY, BX = BY, AB common ⇒ ΔAXB ≅ ΔAYB ⇒ ∠XAO = ∠YAO (where O is the point where AB meets XY).
In ΔAXO and ΔAYO: AX = AY, ∠XAO = ∠YAO, AO common ⇒ ΔAXO ≅ ΔAYO ⇒ OX = OY and ∠XOA = ∠YOA. Since these two angles are supplementary and equal, each is 90°.
So AB satisfies both conditions (bisects XY and is perpendicular to it) — AB is the perpendicular bisector of XY.

Q2. Can you think of different methods to construct a 90° angle at a given point on a line using a rope?

Answer: Use the ancient 3-4-5 rope method (based on the Baudhayana/Sulba-Sutra tradition): mark a rope at 12 equally-spaced units and tie the two ends together to form a closed loop. Peg the joined 0/12 mark at point A on the line. Stretch the rope so the 3-unit mark falls at point B on the line (AB = 3 units), and pull the 8-unit mark taut away from the line to point C (so AC = 4 units and BC = 5 units, going around the loop). Since $3^2 + 4^2 = 9 + 16 = 25 = 5^2$, triangle ABC is right-angled at A (the angle opposite the longest side, BC = 5, is the right angle) — giving a 90° angle at A without any measuring instrument.

Figure It Out (Pages 144-145): Angle Bisection

Q1. Construct at least 4 different angles. Draw their bisectors.

Answer: For each angle ∠ABC: with centre B, draw an arc cutting both arms at points P and Q. With centres P and Q and equal radius, draw arcs intersecting at point D. Join BD and extend — BD is the bisector of ∠ABC, since ΔBPD ≅ ΔBQD (BP = BQ, PD = QD, BD common), giving ∠PBD = ∠QBD. Repeat this method for any angle, in any orientation.

Q2. Construct the 8-petaled figure shown.

Answer: Draw line AB. With centres A and B and equal radius, draw arcs above and below meeting at C and D; join CD — since Δtriangle congruence gives equal adjacent angles summing to 180°, CD is perpendicular to AB, so all four angles at their intersection O are 90°. Bisect each of these four right angles using the method from Q1, producing 8 rays spaced 45° apart (since 90° ÷ 2 = 45°, and 8 × 45° = 360°). Draw a circle centred at O; use the 8 points where the rays cut the circle, plus curved arcs between consecutive rays, to draw the 8 petals.

Q3. In angle bisection, if arcs of equal radius are drawn on the other side, will line OC still be an angle bisector? Explore and justify.

Answer: Let ∠XOY be given, with the usual construction giving bisector ray OC. Extend CO through O to a point D on the opposite side. Since ΔOAC ≅ ΔOBC (SSS, as before), ∠AOC = ∠BOC. Then ∠AOD = 180° – ∠AOC and ∠BOD = 180° – ∠BOC (angles on a straight line); since ∠AOC = ∠BOC, it follows that ∠AOD = ∠BOD.
So yes — ray OD (the opposite extension of OC through O) also bisects the (reflex) angle on the other side, confirming line OC works as an angle bisector regardless of which side the construction arcs are drawn on.

Q4. What other angles can be constructed using angle bisection? Can you construct a 65.5° angle?

Answer: Starting from a constructed 90° angle, repeated bisection gives 45° (90°÷2), then 22.5° (45°÷2). Adding these to 90° or to each other gives further constructible angles: 90°+45°=135°, 90°+22.5°=112.5°, 45°+22.5°=67.5°, and so on.
A 65.5° angle is **not** constructible this way — it doesn't appear among 90°, 45°, 22.5°, 135°, 112.5°, 67.5°, or further bisections/sums of these values. In general, bisecting a 90° angle repeatedly only ever produces angles of the form 90° × (a whole number) ÷ 2^n (or sums of such angles with other constructible angles like 60°), and 65.5° does not fit this pattern.

Q5. Come up with a method to construct the angle bisector using a rope.

Answer: Fix a peg at vertex O. Using a rope of fixed length, mark equal distances OA and OB along the two arms of the angle (so OA = OB). Take a second rope, tie its two ends at A and B, and pull its midpoint taut away from AB to locate point M (so AM = BM). Join OM.
Since OA = OB, AM = BM, and OM is common, ΔOAM ≅ ΔOBM (SSS), so ∠AOM = ∠BOM — ray OM bisects ∠AOB.

Q6. Construct the following figure (a four-petal pattern in a square). How do you construct petals of maximum possible size within a given square?

Answer: Construct square ABJI (using the perpendicular and equal-length methods from earlier questions). Find the midpoints K, L, M, N of its four sides using perpendicular bisectors. With centres K, L, M, N, draw semicircles inside the square with radius equal to half the side length (e.g. AK). This radius is the **maximum possible** that keeps the four semicircles from overlapping each other while staying entirely inside the square — any larger radius would cause adjacent petals to overlap.

Figure It Out (Page 147): Copying Angles and Figures

Q1. Construct at least 4 different angles in different orientations without taking any measurements. Make a copy of all these angles.

Answer: For each given angle ∠ABC, draw a new ray from a new vertex B' in the new orientation. With centre B, draw an arc cutting both arms of the original angle at P and Q. With the same radius and centre B', draw an arc cutting the new ray at P'. With centre P' and radius PQ (measured with a compass from the original), draw an arc cutting the first arc at Q'. Join B'Q' — ∠A'B'C' now equals ∠ABC, since the two triangles formed (BPQ and B'P'Q') are congruent by SSS (equal radii and equal chord length PQ = P'Q').

Q2. Construct the following figure (a fan/spiral of connected sectors).

Answer: Copy the first segment and angle using the angle-copying method from Q1. At each new vertex, draw an arc with radius equal to the previous copied side length, then transfer the length of the corresponding original diagonal using a compass to locate the next point. Join consecutive points and shade alternating sectors, repeating this process around the full figure.

Figure It Out (Page 148): Parallel Lines

Q1. Construct 4 pairs of parallel lines in different orientations.

Answer: Draw line AB and a transversal CD crossing it at point E; choose a point P elsewhere on the transversal. Using the angle-copying method (Q1, page 147), copy the angle the transversal makes with AB at E onto point P, on the same side, to get a new ray through P. This new line through P is parallel to AB, because equal corresponding angles guarantee two lines are parallel (converse of the corresponding-angles rule). Repeat for 4 different orientations.

Q2. Construct the following figure (a rosette of 8 rhombi around a point).

Answer: Since the rosette has 8 identical rhombi arranged around a single point, and 360° ÷ 8 = 45°, each rhombus needs a 45° angle at the centre. Construct a 90° angle at point A (perpendicular-line method), then bisect it to get 45° (90° ÷ 2 = 45°). Using this 45° angle and two equal side-lengths, construct one rhombus. Copy this rhombus 7 more times around point A (using the angle- and length-copying methods) to complete the full 360° rosette (8 × 45° = 360°, so the rhombi fit together with no gap or overlap).

Figure It Out (Page 151): Arch Designs

Q1. Use support lines in the given figure to construct a pointed arch. Make different arches by changing the radius of the arcs.

Answer: Draw a vertical support line. Using a compass, transfer the reference lengths from the given figure onto your construction (equal segments on either side of the vertical line). Find the midpoints of these segments using perpendicular bisectors. Draw matching arcs centred at these midpoints and at the base points, sized to meet at the top — this produces a pointed (Gothic-style) arch. Changing the radius of the arcs changes how pointed or rounded the arch appears.

Q2. Make your own arch design.

Answer: This is open-ended. One approach: draw a vertical line AB; with centre A, draw an arc; from a point C on it, draw another equal arc intersecting the first at D and E; join and extend AD and AE; mark equal points F and G on these rays; find midpoints of AF and AG; draw semicircles on the resulting segments to complete a symmetric custom arch. Any valid ruler-and-compass construction that produces a symmetric arch is acceptable.

Figure It Out (Pages 154-155): Hexagons and Illusions

Q1. Construct the following figures (a-e), based on dividing a circle using its own radius.

Answer: The key technique used throughout: mark a point A on a circle, then — keeping the compass open to exactly the circle's radius — step off six equal chords around the circumference (A→B→C→D→E→F→back to A). Since each chord equals the radius, each step forms an equilateral triangle with the centre O, so each central angle is exactly 60° — and 6 × 60° = 360° brings you back to the start. Joining these six points gives a **regular hexagon inscribed in the circle** (exact, not approximate).

(a) An inflexed-arc pattern: equal perpendicular segments and equal-radius arcs from the segment's midpoint.
(b) The "Flower of Life": from a point on a circle's circumference, step the same radius around to generate six overlapping circles, each centred on the original circle's circumference.
(c) Joining the six hexagon points A-F in order gives the regular hexagon itself.
(d) Joining O to each hexagon point, finding midpoints, and drawing radius-halved circles at each point extends the hexagon pattern further.
(e) Extending each radius to an outer circle of twice the original radius and joining points creates a triangulated mandala pattern. *(The exact count of smaller triangles formed in each ring of this mandala depends on the specific figure in your textbook — check your book's image to confirm the count, since it can vary slightly with how the outer lines are drawn.)*

Q2. Optical Illusion. Do you notice anything interesting about the figure? How does this happen? Recreate it.

Answer: Using the six hexagon-division points on a circle (A-F), join alternating points (AC, CE, EA) to form a large triangle outline, then draw three circles with wedge-shaped notches cut out, positioned at three alternating hexagon points so their notches point toward each other.
This figure is known as the **Kanizsa triangle**, a famous optical illusion first described by the psychologist Gaetano Kanizsa in 1955. Even though no actual triangle is drawn, the human brain "fills in" the missing edges between the notched circles and angled lines, perceiving a bright white triangle that appears to float above the rest of the figure. This happens because our visual system automatically completes partial edges and contours it expects to see (a phenomenon called illusory or subjective contours).

Q3. Construct this figure. (Hint: Find the angles in this figure.)

Answer: Use the same six-point hexagon-division method on a circle (radius-stepping to get points A-F, each 60° apart), then join the specific points as shown in your textbook figure to recreate the pattern — the key insight from the hint is that every angle in these hexagon-based patterns is a multiple of 60°, since the six division points are exactly 60° apart around the circle.

Q4. Draw a line l and mark a point P outside it. Construct a perpendicular to l through P.

Answer: With centre P, draw an arc that cuts line l at two points, A and B. Since PA = PB (both are radii of the same arc), P is equidistant from A and B — meaning P must lie on the perpendicular bisector of AB (by the perpendicular-bisector-locus property proved in earlier questions). So: construct the perpendicular bisector of segment AB using the usual method (equal-radius arcs from A and B, above and below); this bisector automatically passes through P and is perpendicular to line l.

6.2 Tiling — Figure It Out (Page 156)

Q1. How can the tangram pieces be rearranged to form the given figures?

Answer: A standard tangram set has 7 pieces ("tans") cut from one square: 2 large right triangles, 1 medium right triangle, 2 small right triangles, 1 square, and 1 parallelogram. To recreate any target silhouette, arrange all 7 pieces edge-to-edge with no gaps or overlaps, using rotation and flipping as needed, until the outline matches the target figure shown in your textbook. Tangram puzzles typically have multiple valid arrangements, so experiment with different rotations of each piece.

Figure It Out (Page 160): Can It Be Tiled?

Q1. Is the following tiling possible?

Answer: To check whether a region can be tiled by a given tile shape, compare the region's total area to the tile's area: if the region's area is an exact whole-number multiple of one tile's area, tiling *may* be possible (this is necessary, though not always sufficient, since the shapes also need to fit together without gaps). For the region and tile shown in this question, the area works out to exactly 4 times the tile's area, so the region can be tiled using 4 tiles of the given shape, arranged to fit the boundary exactly.

Q2. Is the following tiling possible? (2×1 domino tiles on a chessboard-style region)

Answer: Colour the given region like a checkerboard (alternating black and white squares). Counting the squares: there are 30 black squares and 32 white squares.
Every 2×1 domino tile, no matter where or how it's placed on a checkerboard-coloured grid, always covers exactly **one black square and one white square** (since any two adjacent squares are always different colours). This means any complete tiling by such dominoes must cover an **equal** number of black and white squares.
Since this region has 30 black squares but 32 white squares — an unequal count — it is **impossible** to tile this region completely using 2×1 domino tiles, no matter how they are arranged. (This is the same reasoning used in the classic "mutilated chessboard" puzzle.)

Practice more: Extra Questions for Class 7 Maths Chapter 14

Quick revision: Revision Notes for Class 7 Maths Chapter 14