Grade: 9 CBSE

Subject: Mathematics

Chapter: The World of Numbers

SECTION A — MULTIPLE CHOICE QUESTIONS (5 Marks)

1. In an isosceles right-angled triangle with leg lengths of 1 unit each, the length of the hypotenuse is: [1]

(A) 1 unit

(B) √2 units

(C) 2 units

(D) √3 units

2. In the Theodorus Square Root Spiral, if the n-th right triangle has a hypotenuse of length √n and a unit perpendicular of 1, the hypotenuse of the next contiguous triangle is: [1]

(A) √(n + 1)

(B) n + 1

(C) √n + 1

(D) 2√n

3. Every point on the continuous real number line represents: [1]

(A) Only a rational number

(B) Only an irrational number

(C) A unique real number (which can be either rational or irrational)

(D) A natural number only

4. Which fundamental geometric theorem serves as the mathematical foundation for constructing the Square Root Spiral? [1]

(A) Thales Theorem (Basic Proportionality Theorem)

(B) Pythagoras Theorem

(C) Apollonius Theorem

(D) Ptolemy's Theorem

5. The irrational number √5 lies strictly between which two consecutive integers on the number line? [1]

(A) 1 and 2

(B) 2 and 3

(C) 3 and 4

(D) 4 and 5

SECTION B — VERY SHORT / SHORT ANSWER QUESTIONS (10 Marks)

6. Describe step-by-step how to construct and locate the irrational number $\sqrt{2}$ on the real number line using a unit square. [2]

7. Construct a single right-angled triangle on the number line to locate $\sqrt{5}$ in a single step (using a base of 2 units and a perpendicular of 1 unit). Show the algebraic calculation. [2]

8. Expand and simplify the radical product: $(5 + \sqrt{7})(2 + \sqrt{5})$. [2]

9. Evaluate and simplify using algebraic identities: $(\sqrt{11} - \sqrt{7})(\sqrt{11} + \sqrt{7})$. [2]

10. Calculate the numerical value of: $(3 + \sqrt{3})(3 - \sqrt{3}) + (2 + \sqrt{2})^2$. [2]

SECTION C — APPLICATION & LOGICAL THINKING QUESTIONS (10 Marks)

11. Theodorus Spiral geometry and sequential root properties.

(a) In the Theodorus Square Root Spiral, the first triangle T1 has hypotenuse $\sqrt{2}$, T2 has hypotenuse $\sqrt{3}$, and so on. Determine the hypotenuse of triangle T15. How many contiguous right triangles must be constructed starting from unit base to produce a hypotenuse of exact integer length 4? [3]

(b) Explain why the vertices of the hypotenuses in the square root spiral do not lie on a circle, and describe how the distance from the origin changes as the spiral expands. [2]

12. Surd rationalization and algebraic expressions.

(a) Rationalize the denominator and simplify the expression to its lowest radical form: $(4\sqrt{3} + 5\sqrt{2}) / (\sqrt{48} + \sqrt{18})$. [3]

(b) If $x = 3 + 2\sqrt{2}$, evaluate: (i) $x + 1/x$, and (ii) $x^2 + 1/x^2$. [2]

SECTION D — CASE STUDY / DIAGRAM-BASED QUESTION (5 Marks)

13. Case Study: In the 5th century BCE, Theodorus of Cyrene developed an elegant iterative geometric construction known as the Square Root Spiral. Starting from an initial right-angled triangle with unit legs, each subsequent triangle is constructed using the hypotenuse of the previous triangle as its base and attaching a perpendicular of unit length 1, as charted in Figure 2.1.

Refer to Figure 2.1 to answer the following questions:

(a) State the lengths of the base and perpendicular of the first right-angled triangle in Figure 2.1, and verify using the Pythagorean theorem that its hypotenuse equals $\sqrt{2}$. [1]

(b) Explain how the length of the hypotenuse representing $\sqrt{2}$ is projected onto the horizontal real number line. What point on the number line serves as the center of the arc? [1]

(c) Trace the iterative step from $\sqrt{4}$ to $\sqrt{5}$. State the length of the base and perpendicular for this step, calculate the hypotenuse length, and state its approximate decimal location on the number line. [3]

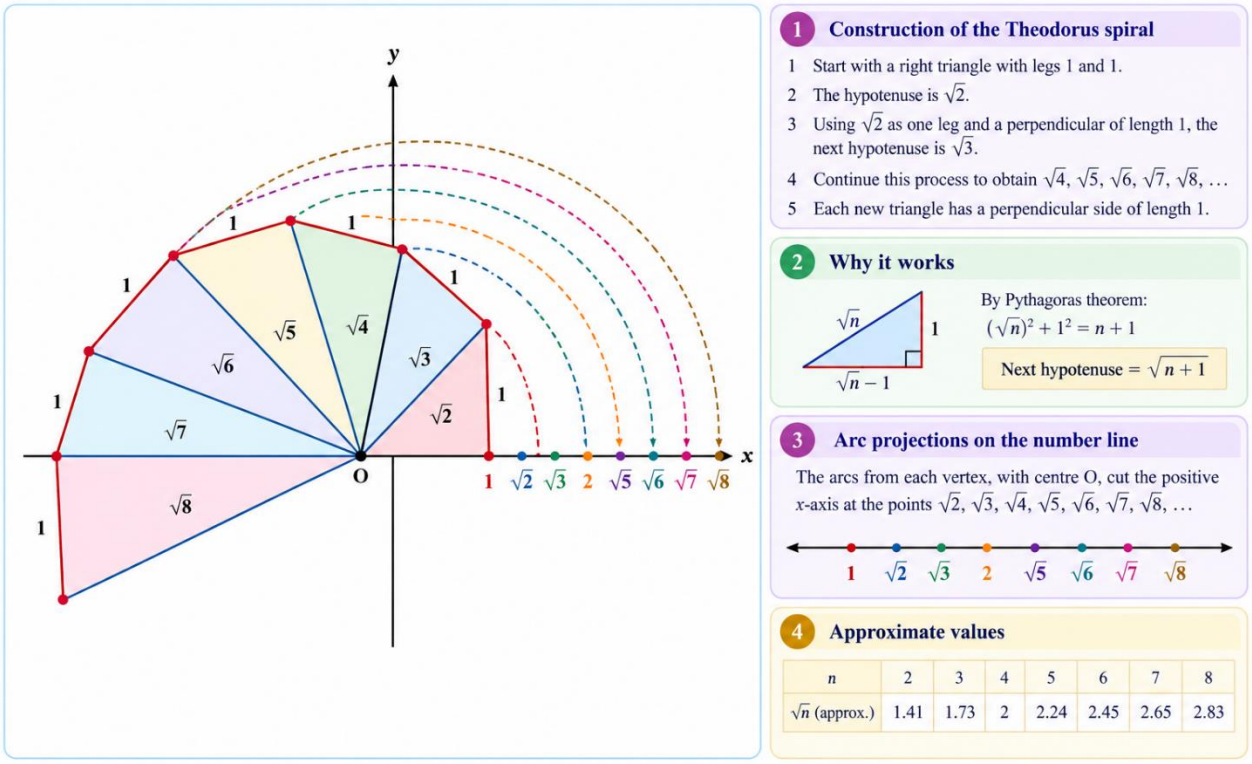


Figure 2.1: Theodorus Square Root Spiral showing iterative construction of √2, √3, √4, √5, √6, √7, and their arc projections onto the number line.

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