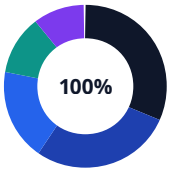
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COMPLETE QUANTITATIVE APTITUDE — ARITHMETIC & ADVANCE MATHS

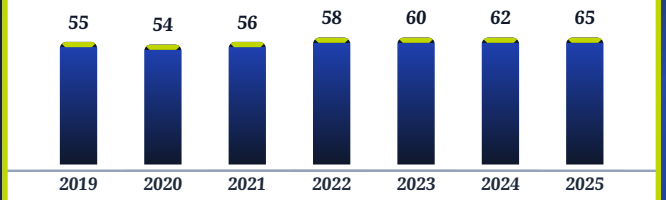
Number System, HCF-LCM, Percentage, Profit & Loss, SI & CI, Ratio, Time & Work, Speed-Time-Distance, Algebra, Trigonometry, Height & Distance, Geometry, Mensuration 2D/3D, Statistics & Data Interpretation

Topic-Wise Exam Weightage Distribution (%)



Commercial Arithmetic	32%
Advance Maths	28%
Time &	18%
Number System	12%
Data Interpretation	10%

Previous Years' Question Trend Analysis



Target Competitive, Entrance & Departmental Examinations

SSC CGL/CHSL/CPO/GD • Railway NTPC/Group-D/ALP/RPF • Banking PO/Clerk • CDS/AFCAT • Police • UPSC/PCS CSAT

Core Syllabus Pillars & Exam Question Weightage (%)

- Commercial Arithmetic (Percentage, Profit-Loss, SI-CI, Ratio, Average) (32%)
- Advance Maths (Geometry, Mensuration 2D/3D, Algebra, Trigonometry) (28%)
- Time & Work, Pipes & Cisterns, Speed-Distance, Trains, Boats & Streams (18%)
- Number System, Divisibility, Remainders, HCF-LCM, Surds & Indices (12%)
- Data Interpretation (DI), Statistics, Permutations & Probability (10%)

Complete Theory
NCERT & Official Sources

Visual Flowcharts
Comparative Matrices

Memory Tricks
Exam Trap Alerts

75+ Solved MCQs
One-Liner Capsules

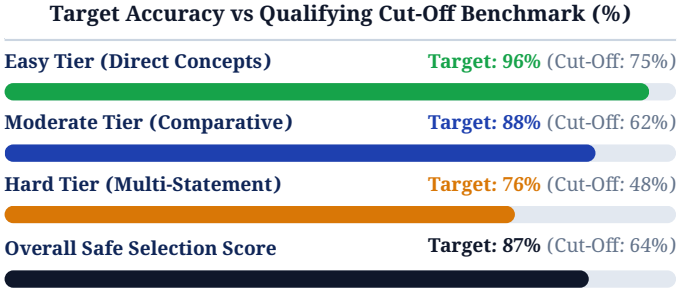
Preface, Exam Weightage Dashboard & Study Strategy — COMPLETE QUANTITATIVE APTITUDE — ARITHMETIC & ADVANCE MATHS

IUC Academy (Inclusive Universal Careers Academy | www.iucacademy.com) • Official English Medium Study Notes

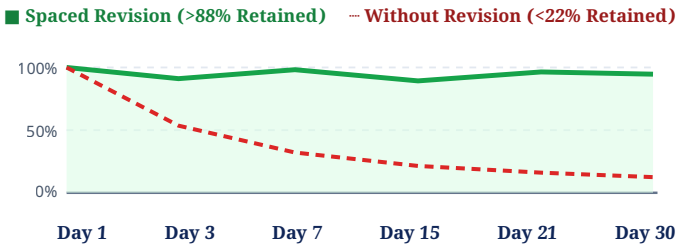
Dear Aspirants,

Modern competitive, entrance, and departmental promotion examinations demand a combination of deep conceptual clarity, statutory precision, and rapid revision tools. Prepared by **Inclusive Universal Careers Academy (IUC Academy — www.iucacademy.com)**, these comprehensive English-medium study notes integrate **structured chapter theory, 4-node conceptual process flowcharts, multi-column comparative tables, inline mathematical/scientific formulas, 'Did You Know?' boxes, 'Exam Trap Alert' callouts, 'Memory Trick' mnemonics, Chapter-End Analytical Synthesis Matrices, 75+ Step-by-Step Solved MCQs, and Rapid-Fire One-Liner Revision Capsules**.

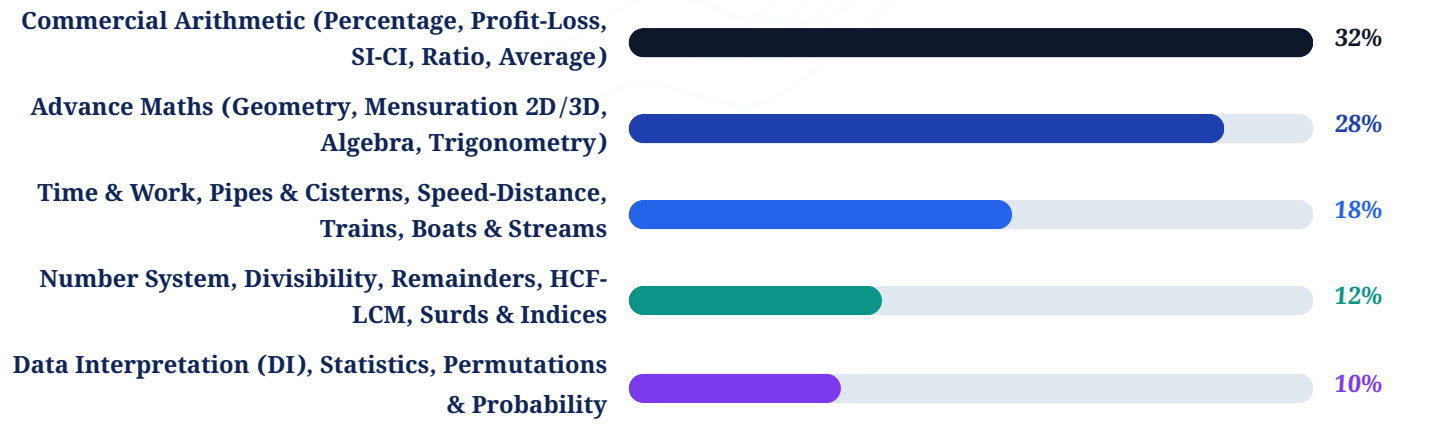
Target Accuracy vs Qualifying Cut-Off Benchmark (%)



Spaced Revision (1-3-7-21 Day Rule) & Retention Curve



Topic-Wise Exam Question Weightage Index (%)



Verified Official Curriculum & Statutory Reference Portals

- **SSC Official Portal** (https://ssc.gov.in/)
- **NCERT Mathematics Textbooks** (https://ncert.nic.in/textbook.php)
- **IUC Academy Official Portal** (https://www.iucacademy.com)

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COMPLETE QUANTITATIVE APTITUDE — ARITHMETIC & ADVANCE MATHS • Complete Chapters, Comparative Matrices, Solved MCQs & Rapid Revision

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- 1.2 Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds

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10. Extended Comparative & Analytical Practice Set (Questions 36–75)

11. Rapid-Fire Last-Minute One-Liner Revision Capsule

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Official Curriculum Alignment: Staff Selection Commission (SSC) | NCERT Mathematics Textbooks

Edition: Pure English Comprehensive Study Notes for SSC CGL/CHSL/CPO/MTS, IBPS/SBI PO & Clerk, CDS, NDA, EPFO & CSAT

Chapter 1: Number System, Divisibility, Remainder Theorems, HCF-LCM & Surds

Chapter Key Study Pillars — Chapter 1: Number System, Divisibility, Remainder Theorems, HCF-LCM & Surds

Key Study Pillar 1
Classification of Real Numbers, Prime Properties & Divisibility Rules

Key Study Pillar 2
Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds

1.1 Classification of Real Numbers, Prime Properties & Divisibility Rules

• **Hierarchy of Real Numbers:**

• **Natural Numbers (N): {1, 2, 3, 4, ...}**. Sum of first **n** natural numbers = **n(n + 1) / 2**; Sum of squares of first **n** natural numbers = **n(n + 1)(2n + 1) / 6**; Sum of cubes of first **n** natural numbers = **[n(n + 1) / 2]^2**.

• **Whole Numbers (W): {0, 1, 2, 3, ...}** | **Integers (Z): {..., -2, -1, 0, 1, 2, ...}**.

• **Rational (Q) vs Irrational Numbers:** A Rational number can be expressed as **p / q** (**q != 0**, terminating or recurring decimals like **0.333... = 1/3**, **0.2727... = 27/99 = 3/11**), whereas an Irrational number has a non-terminating, non-repeating decimal expansion (**sqrt(2), sqrt(3), pi, e**).

• **Prime, Composite & Co-Prime Numbers: 1 is neither prime nor composite**; **2 is the only even prime number** (and smallest prime); **4 is the smallest composite number** (and **9** is the smallest odd composite number). There are **15 primes between 1 and 50** and **25 primes between 1 and 100** (**168** primes up to **1000**). Every prime number **p > 3** can be written in the form **6k + 1** or **6k - 1**. Two integers **a** and **b** are **Co-Prime (Relatively Prime)** if **HCF(a, b) = 1**.

• **Complete Divisibility Rules (Base-10):**

• **By 2^n (2, 4, 8, 16):** Last **1, 2, 3, 4** digits respectively must be divisible by **2, 4, 8, 16**.

• **By 3 and 9:** Sum of all digits must be divisible by **3** or **9** respectively (the remainder when any integer is divided by **9** equals the digital root / sum of its digits modulo **9**).

• **By 5^n (5, 25, 125):** Last **1, 2, 3** digits must be divisible by **5, 25, 125**.

• **By 6 / 12 / 72 / 88 / 99:** Split into **co-prime factors** (**6 = 2 3**; **12 = 3** 4; **72 = 8 9**; **88 = 8** 11; **99 = 9 * 11**) and test divisibility by both co-prime factors simultaneously.

• **By 11: (Sum of digits at odd places) - (Sum of digits at even places)** must be **0** or a multiple of **11**.

• **By 7, 11, and 13 (Combined 1001 Rule):** Since **7 11 13 = 1001**, any 6-digit number formed by repeating a 3-digit number twice (**abcabc = abc 1001**) *is* ***always divisible by*** **7, 11, 13, 77, 91, 143,** ***and*** **1001**.

Similarly, **ab** 101 = abab is always divisible by **101**, and **ab * 10101 = ababab** is always divisible by **3, 7, 13, 37,** and **10101**.

Step-by-Step Conceptual Process Flowchart

STEP 1
Factorize Number into Prime Powers

STEP 2
Compute Total/Even/Odd Factors & Sum

STEP 3
Apply Cyclicity of Unit Digit (Power mod 4)

STEP 4
Evaluate Remainder via Euler / Fermat / Wilson

Divisibility / Remainder Theorem	Exact Mathematical Formula (Inline Notation)	Core Condition & Competitive Application	Official Reference
Canonical Prime Factorization	**N = (p1^a) (p2^b) (p3^c)**	Total Factors = **(a + 1)(b + 1)(c + 1)**	NCERT Textbooks
Sum of All Factors of N	**[(p1^(a+1) - 1)/(p1 - 1)] * [(p2^(b+1) - 1)/(p2 - 1)]**	If **p1 = 2**, set **2^0 -> 0** to find Sum of Even Factors	SSC Exam Portal
Fermat's Little Theorem	**Remainder of [a^(p - 1) / p] = 1**	**p** is prime and **HCF(a, p) = 1**	IUC Academy
Euler's Totient Theorem	**Remainder of [a^phi(N) / N] = 1**	**HCF(a, N) = 1**, where **phi(N) = N(1 - 1/p1)(1 - 1/p2)**	IUC Academy
Wilson's Prime Theorem	**Remainder of [(p - 1)! / p] = (p - 1)** or **-1**	Holds if and only if **p** is a prime number	SSC Exam Portal
Binomial Remainder Identity	**Remainder of [(k*n + r)^m / n] = Remainder of [r^m / n]**	**(x^n - a^n)** is always divisible by **(x - a)** for all **n**	NCERT Textbooks

1.2 Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds

• **Number of Trailing Zeros in n! (Legendre's Formula):** Highest power of **5** in **n!** = **floor(n/5) + floor(n/25) + floor(n/125) + floor(n/625) + ...** (e.g., Trailing zeros in **100! = 20 + 4 = 24**; in **500! = 100 + 20 + 4 = 124**).

• **Unit Digit Cyclicity Rules:**

• **Cyclicity 1 (Digits 0, 1, 5, 6):** Any positive integer power of a number ending in **0, 1, 5,** or **6** ends in the **same digit** (**0, 1, 5, 6**).

• **Cyclicity 2 (Digits 4 and 9):** **4^(Odd) -> 4**, **4^(Even) -> 6**; **9^(Odd) -> 9**, **9^(Even) -> 1**.

• **Cyclicity 4 (Digits 2, 3, 7, 8):** Divide the exponent by **4** (only the last two digits of the exponent need to be divided by **4**); if the remainder is **1, 2, 3**, use that remainder as the power; if the remainder is **0**, use **power 4**!

• **HCF and LCM Master Identities:**

• For any two positive numbers **A** and **B**: **A *B* = *HCF(A, B)* LCM(A, B)**. If **HCF = H**, then **A = H *x*** *and* **B = *H*** y where **HCF(x, y) = 1**, and **LCM = H *x* y**.

• **HCF and LCM of Fractions:** **HCF of Fractions = HCF(Numerators) / LCM(Denominators)**; **LCM of Fractions = LCM(Numerators) / HCF(Denominators)**.

• **Remainder Word-Problem Patterns:**

• Largest number that divides **A, B, C** leaving remainders **r1, r2, r3** = **HCF(A - r1, B - r2, C - r3)**.

• Largest number that divides **A, B, C** leaving the **same (unknown) remainder** = **HCF(|A - B|, |B - C|, |C - A|)**.

• Smallest number which when divided by **x, y, z** leaves the same remainder **r** = **k * LCM(x, y, z) + r**.

• Smallest number which when divided by **x, y, z** leaves remainders **a, b, c** such that **(x - a) = (y - b) = (z - c) = d** (constant difference) = **k * LCM(x, y, z) - d**.

• **Infinite Nested Radicals (Surds & Indices):**

• **sqrt(a *sqrt(a* sqrt(a ... to infinity))) = a**.

• **sqrt(a *sqrt(a* sqrt(a ... up to n terms))) = a^[(2^n - 1) / (2^n)]**.

• **sqrt(a + sqrt(a + sqrt(a + ... to infinity))) = [sqrt(4a + 1) + 1] / 2** (if **a = m(m + 1)** is a product of two consecutive integers, the positive root is simply the larger factor **(m + 1)**).

• **sqrt(a - sqrt(a - sqrt(a - ... to infinity))) = [sqrt(4a + 1) - 1] / 2** (if **a = m(m + 1)**, the positive root is the smaller factor **m**).

Did You Know?: For any odd natural number **n**, **(x^n + a^n)** **is always divisible by** **(x + a)** (which guarantees that **17^23 + 29^23** is divisible by **17 + 29 = 46**), and for any even natural number **n**, **(x^n - a^n)** **is always divisible by both** **(x - a)** **and** **(x + a)**, as proven in NCERT Algebraic Identities.

Exam Trap Alert: When finding the number of **Odd Factors** of **N = (2^a) (3^*b*) (5^c)**, ignore the power of **2** completely (**Odd Factors = (b + 1)(c + 1)**), whereas for **Even Factors**, multiply **a** (NOT **a + 1**) by the remaining increments (**Even Factors = a (*b* + 1) (c + 1)**). Also remember that a number has an **odd number of total factors if and only if it is a Perfect Square**!

★ **Memory Trick:** For nested surds **sqrt(12 + sqrt(12 + ...))** vs **sqrt(12 - sqrt(12 - ...))**, factor **12 = 3 * 4**: **Plus (+) picks the Bigger neighbor (4), Minus (-) picks the Smaller neighbor (3)**!

Chapter *1* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Classification of Real Numbers, Prime Properties & Divisibility Rules	**Natural Numbers (N)**	**{1, 2, 3, 4, ...}**. Sum of first **n** natural numbers = **n(n + 1) / 2**; Sum of squares of first **n** natural numbers = **n(n + 1)(2n + 1) / 6**; Sum of cubes of first **n** natural numbers = **[n(n + 1) / 2]^2**.
Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds	**Whole Numbers (W)**	**{0, 1, 2, 3, ...}** | **Integers (Z): {..., -2, -1, 0, 1, 2, ...}**.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Classification of Real Numbers, Prime Properties & Divisibility Rules	**Rational (Q) vs Irrational Numbers**	A Rational number can be expressed as **p / q** (**q != 0** , terminating or recurring decimals like **0.333... = 1/3** , **0.2727... = 27/99 = 3/11**), whereas an Irrational number has a non-terminating, non-repeating decimal expansion (**sqrt(2), sqrt(3), pi, e**).
Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds	**Prime, Composite & Co-Prime Numbers**	**1** **is neither prime nor composite**; **2** **is the only even prime number** (and smallest prime); **4** **is the smallest composite number** (and **9** is the smallest odd composite number). There are **15** **primes between** **1** **and** **50** and **25** **primes between** **1** **and** **100** (**168** primes up to **1000**). Every prime number **p > 3** can be written in the form **6k + 1** **or** **6k - 1** . Two integers **a** and **b** are **Co-Prime (Relatively Prime)** if **HCF(a, b) = 1** .
Classification of Real Numbers, Prime Properties & Divisibility Rules	**By 2^n (2, 4, 8, 16)**	Last **1, 2, 3, 4** digits respectively must be divisible by **2, 4, 8, 16** .
Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds	**By 3 and 9**	Sum of all digits must be divisible by **3** or **9** respectively (the remainder when any integer is divided by **9** equals the digital root / sum of its digits modulo **9**).
Classification of Real Numbers, Prime Properties & Divisibility Rules	**By 5^n (5, 25, 125)**	Last **1, 2, 3** digits must be divisible by **5, 25, 125** .
Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds	**By 6 / 12 / 72 / 88 / 99**	Split into **co-prime factors** (**6 = 2 3** ; **12 = 3** 4; **72 = 8 9** ; **88 = 8** 11; **99 = 9 * 11**) and test divisibility by both co-prime factors simultaneously.
Classification of Real Numbers, Prime Properties & Divisibility Rules	**By 11**	**(Sum of digits at odd places) - (Sum of digits at even places)** must be **0** or a multiple of **11** .
Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds	**By 7, 11, and 13 (Combined 1001 Rule)**	Since **7 11 13 = 1001** , any 6-digit number formed by repeating a 3-digit number twice (**abcabc = abc 1001**) *is* ***always divisible by*** **7, 11, 13, 77, 91, 143,** ***and*** **1001** . *Similarly,* ***ab*** 101 = abab is always divisible by **101** , and **ab * 10101 = ababab** is always divisible by **3, 7, 13, 37,** and **10101** .
Classification of Real Numbers, Prime Properties & Divisibility Rules	**Number of Trailing Zeros in n! (Legendre's Formula)**	Highest power of **5** in **n!** = **floor(n/5) + floor(n/25) + floor(n/125) + floor(n/625) + ...** (e.g., Trailing zeros in **100! = 20 + 4 = 24** ; in **500! = 100 + 20 + 4 = 124**).
Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds	**Cyclicity 1 (Digits 0, 1, 5, 6)**	Any positive integer power of a number ending in **0, 1, 5,** or **6** ends in the **same digit** (**0, 1, 5, 6**).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Classification of Real Numbers, Prime Properties & Divisibility Rules	**Cyclicity 2 (Digits 4 and 9)**	**4^(Odd) -> 4**, **4^(Even) -> 6**; **9^(Odd) -> 9**, **9^(Even) -> 1**.
Factors, Trailing Zeros, Unit Digit Cyclicity, HCF-LCM & Surds	**Cyclicity 4 (Digits 2, 3, 7, 8)**	Divide the exponent by **4** (only the last two digits of the exponent need to be divided by **4**); if the remainder is **1, 2, 3**, use that remainder as the power; if the remainder is **0**, use **power 4**!

Chapter *1* Multi-Statement Exam Verification Drills

Chapter 1 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Natural Numbers (N)): **{1, 2, 3, 4, ...}**. Sum of first **n** natural numbers = **n(n + 1) / 2**; Sum of squares of first **n** natural numbers = **n(n + 1)(2n + 1) / 6**; Sum of cubes of first **n** natural numbers = **[n(n + 1) / 2]^2**.

Statement-II (Whole Numbers (W)): **{0, 1, 2, 3, ...}** | **Integers (Z):** **{..., -2, -1, 0, 1, 2, ...}**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 1 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Rational (Q) vs Irrational Numbers): A Rational number can be expressed as **p / q** (**q != 0**, terminating or recurring decimals like **0.333... = 1/3**, **0.2727... = 27/99 = 3/11**), whereas an Irrational number has a non-terminating, non-repeating decimal expansion (**sqrt(2), sqrt(3), pi, e**).

Statement-II (Prime, Composite & Co-Prime Numbers): **1 is neither prime nor composite**; **2 is the only even prime number** (and smallest prime); **4 is the smallest composite number** (and **9** is the smallest odd composite number). There are **15 primes between 1 and 50** and **25 primes between 1 and 100** (**168** primes up to **1000**). Every prime number **p > 3** can be written in the form **6k + 1** or **6k - 1**. Two integers **a** and **b** are **Co-Prime (Relatively Prime)** if **HCF(a, b) = 1**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 1 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (By 2^n (2, 4, 8, 16)): Last **1, 2, 3, 4** digits respectively must be divisible by **2, 4, 8, 16**.

Statement-II (By 3 and 9): Sum of all digits must be divisible by **3** or **9** respectively (the remainder when any integer is divided by **9** equals the digital root / sum of its digits modulo **9**).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 1 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (By 5^n (5, 25, 125)): Last **1, 2, 3** digits must be divisible by **5, 25, 125**.

Statement-II (By 6 / 12 / 72 / 88 / 99): Split into **co-prime factors** (**6 = 2 3**; **12 = 3** 4; **72 = 8 9**; **88 = 8** 11; **99 = 9 * 11**) and test divisibility by both co-prime factors simultaneously.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 1 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (By 11): **(Sum of digits at odd places) - (Sum of digits at even places)** must be **0** or a multiple of **11**.

Statement-II (By 7, 11, and 13 (Combined 1001 Rule)): Since **7 11 13 = 1001**, any 6-digit number formed by repeating a 3-digit number twice (**abcabc = abc 1001**) *is* ***always divisible by*** **7, 11, 13, 77, 91, 143,** ***and*** **1001**. *Similarly,* ***ab*** 101 = abab is always divisible by **101**, and **ab * 10101 = ababab** is always divisible by **3, 7, 13, 37,** and **10101**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 1 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Number of Trailing Zeros in n! (Legendre's Formula)): Highest power of **5** in **n!** = **floor(n/5) + floor(n/25) + floor(n/125) + floor(n/625) + ...** (e.g., Trailing zeros in **100! = 20 + 4 = 24**; in **500! = 100 + 20 + 4 = 124**).

Statement-II (Cyclicity 1 (Digits 0, 1, 5, 6)): Any positive integer power of a number ending in **0, 1, 5,** or **6** ends in the **same digit** (**0, 1, 5, 6**).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 2: Percentage, Profit-Loss-Discount & Simple/Compound Interest

Chapter Key Study Pillars — Chapter 2: Percentage, Profit-Loss-Discount & Simple/Compound Interest

Key Study Pillar 1
Percentage-Fraction Equivalence & Successive Change Formulae

Key Study Pillar 2
Profit, Loss, Discount & Simple vs Compound Interest

2.1 Percentage-Fraction Equivalence & Successive Change Formulae

• **High-Speed Fraction-to-Percentage Table:**

• **1/2 = 50%** | **1/3 = 33.33%** | **1/4 = 25%** | **1/5 = 20%** | **1/6 = 16.67% (16 2/3%)** | **1/7 = 14.28% (14 2/7%)** | **1/8 = 12.5%** | **1/9 = 11.11% (11 1/9%)** | **1/11 = 9.09% (9 1/11%)** | **1/12 = 8.33% (8 1/3%)** | **1/13 = 7.69%** | **1/14 = 7.14%** | **1/15 = 6.67%** | **1/16 = 6.25%** | **3/8 = 37.5%** | **5/8 = 62.5%** | **7/8 = 87.5%** | **4/7 = 57.14%**.

• **Product Constancy Rule (Price *Consumption* = *Expenditure*):** *If a quantity increases by* ***R%*** *(or fraction* ***a / b****), then to keep the product constant, the second quantity must decrease by* **[R / (100 + R)]** **100%** (or fraction **a / (a + b)**). Conversely, if the first decreases by **a / b**, the second must increase by **a / (b - a)**.

• **Net Successive Percentage Change (A-B Formula):** Two successive changes of **x%** and **y%** produce a single net percentage change of **(x + y + (x y) / 100)%** (*use negative signs for decreases/discounts). For population or asset depreciation over* ***n*** *years at rate* ***R%*** : ***Final Value* = *Initial*** (1 + R/100)^n (growth) or **Initial * (1 - R/100)^n** (depreciation).

Step-by-Step Conceptual Process Flowchart

STEP 1 — **Anchor Base Value (CP for Profit, MP for Discount)**

STEP 2 — **Apply Ratio or Successive Multiplier**

STEP 3 — **Equate CP-to-MP Golden Ratio**

STEP 4 — **Compute Exact Margin, True Weight or CI-SI Diff**

Commercial Arithmetic Concept	Exact Formula (Clean Single-Line Notation)	Base Quantity & Key Exam Rule	Official Portal
Profit % & Loss %	**Profit% = [(SP - CP) / CP] 100** ; ***Loss%* = *[(CP - SP) / CP]*** 100	Always calculated on **Cost Price (CP)** unless specified	NCERT Textbooks
Discount % & Equivalent Discount	**Discount% = [(MP - SP) / MP] 100** ; ***Net D%* = *d1* + *d2* - (*d1* d2)/100**	Always calculated on **Marked Price (MP / List Price)**	SSC Exam Portal
Golden Ratio of CP : MP	**CP / MP = (100 - Discount%) / (100 + Profit%)**	Links Cost Price and Marked Price directly in 1 step	IUC Academy
Dishonest Dealer (False Weight)	**True Profit% = [(True Weight - False Weight) / False Weight] * 100**	Denominator is always the **actual weight delivered**	SSC Exam Portal
2-Year & 3-Year CI - SI Difference	**Diff_2yr = P (*R* / 100)^2** ; ***Diff_3yr = P*** (R / 100)^2 * (3 + R / 100)	Ratio **(CI - SI)_3yr : (CI - SI)_2yr = (300 + R) : 100**	IUC Academy

2.2 Profit, Loss, Discount & Simple vs Compound Interest

• **Special Profit-Loss Identities:**

• **Same Selling Price (SP1 = SP2) with x% Profit on one and x% Loss on the other:** Always results in an overall **Net Loss of (x^2 / 100)%**, and **Loss Amount = (2 *SP* (x/100)^2) / [1 - (x/100)^2]**.

• **Same Cost Price (CP1 = CP2) with x% Profit on one and x% Loss on the other:** Overall result is **No Profit, No Loss (0%)**.

• **Buy A Get B Free Scheme: Effective Discount% = [B / (A + B)] * 100%**.

• **Simple Interest (SI) vs Compound Interest (CI):**

• **Simple Interest: SI = (P *R* T) / 100**; **Amount A = P + SI**. If a sum becomes **n** times itself in **T** years at SI, then **(n - 1) = (R *T*) / 100**; *to become* ***m*** *times itself, time required* ***T2 = [(m - 1) / (n - 1)]*** T1.

• **Compound Interest: Amount A = P * (1 + R / 100)^n**; **CI = A - P**.

• **Half-Yearly Compounding:** Rate becomes **R / 2** and time periods become **2n**.

• **Quarterly Compounding:** Rate becomes **R / 4** and time periods become **4n**.

• **8-Monthly Compounding:** Rate becomes **R (8/12) = (2/3)*R*** *and periods become* ***n*** (12/8).

• **Pascal's Triangle Tree Multipliers for CI:** For **2 years** -> **2 : 1**; for **3 years** -> **3 : 3 : 1**; for **4 years** -> **4 : 6 : 4 : 1**.

• **Equal Installments Formulas:**

• **SI Equal Annual Installment (x) for Debt A due in n years at R%: Debt Due A = n*x* + [*x* R *n*(*n* - 1)] / (2 100)**.

• **CI Equal Annual Installment (x) for Principal Loan P borrowed at R%:**
P = x / (1 + R/100)^1 + x / (1 + R/100)^2 + ... + x / (1 + R/100)^n.

Did You Know?: In Compound Interest, the amounts at the end of equal time intervals Always form a **Geometric Progression (GP)**! Therefore, if a principal `P` becomes `A1` in `t` years and `A2` in `2t` years under CI, then `P = (A1)^2 / A2`, and the interest of the `(k + 1)`-th year is simply `(1 + R/100)` times the interest of the `k`-th year, as verified in [IUC Academy Quantitative Notes].

Exam Trap Alert: Never apply the `x^2 / 100 %` loss shortcut when two items have the **same Cost Price (`CP1 = CP2`)**! That formula applies **strictly when two items are sold at the same Selling Price (`SP1 = SP2`)**. Also, in **SI Debt Installments**, the given total amount is the **Amount Due at Maturity (`A`)**, whereas in **CI Loan Installments**, the given sum is the **Present Principal Borrowed (`P`)**!

★ **Memory Trick:** Remember the **Golden Ratio** `CP : MP = (100 - D%) : (100 + P%)` — put `D` (Discount) with `CP` and `P` (Profit) with `MP`!

Chapter *2* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Percentage-Fraction Equivalence & Successive Change Formulae	**Product Constancy Rule (`Price * Consumption = Expenditure`)**	**If a quantity increases by `R%` (or fraction `a / b`), then to keep the product constant, the second quantity must decrease by `[R / (100 + R)] 100%` (*or fraction `a / (a + b)`*). *Conversely, if the first decreases by `a / b`, the second must increase by `a / (b - a)`*.**
Profit, Loss, Discount & Simple vs Compound Interest	**Net Successive Percentage Change (`A-B` Formula)**	Two successive changes of `x%` and `y%` produce a single net percentage change of `(x + y + (x y) / 100)%` (*use negative signs for decreases/discounts*). *For population or asset depreciation over `n` years at rate `R%`*: `Final Value = Initial` (1 + R/100)^n (growth) or `Initial * (1 - R/100)^n` (depreciation).
Percentage-Fraction Equivalence & Successive Change Formulae	**Same Selling Price (`SP1 = SP2`) with `x%` Profit on one and `x%` Loss on the other**	Always results in an overall **Net Loss of `(x^2 / 100)%`**, and `Loss Amount = (2 SP (x/100)^2) / [1 - (x/100)^2]`.
Profit, Loss, Discount & Simple vs Compound Interest	**Same Cost Price (`CP1 = CP2`) with `x%` Profit on one and `x%` Loss on the other**	Overall result is **No Profit, No Loss (`0%`)**.
Percentage-Fraction Equivalence & Successive Change Formulae	**Buy `A` Get `B` Free Scheme**	`Effective Discount% = [B / (A + B)] * 100%`.
Profit, Loss, Discount & Simple vs Compound Interest	**Simple Interest**	`SI = (P R T) / 100`; `Amount A = P + SI`. If a sum becomes `n` times itself in `T` years at SI, then `(n - 1) = (R T) / 100`; *to become `m` times itself, time required* `T2 = [(m - 1) / (n - 1)]` T1.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Percentage-Fraction Equivalence & Successive Change Formulae	Compound Interest	`Amount A = P * (1 + R / 100)^n`; `CI = A - P`.
Profit, Loss, Discount & Simple vs Compound Interest	Half-Yearly Compounding	Rate becomes `R / 2` and time periods become `2n`.
Percentage-Fraction Equivalence & Successive Change Formulae	Quarterly Compounding	Rate becomes `R / 4` and time periods become `4n`.
Profit, Loss, Discount & Simple vs Compound Interest	8-Monthly Compounding	Rate becomes `R (8/12) = (2/3)R` *and periods become* `n` (12/8).
Percentage-Fraction Equivalence & Successive Change Formulae	Pascal's Triangle Tree Multipliers for CI	For `2 years` -> `2 : 1`; for `3 years` -> `3 : 3 : 1`; for `4 years` -> `4 : 6 : 4 : 1`.
Profit, Loss, Discount & Simple vs Compound Interest	SI Equal Annual Installment (`x`) for Debt `A` due in `n` years at `R%`	`Debt Due A = nx + [x R n(n - 1)] / (2 100)`.
Percentage-Fraction Equivalence & Successive Change Formulae	CI Equal Annual Installment (`x`) for Principal Loan `P` borrowed at `R%`	`P = x / (1 + R/100)^1 + x / (1 + R/100)^2 + ... + x / (1 + R/100)^n`.

Chapter 2 Multi-Statement Exam Verification Drills

Chapter 2 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Product Constancy Rule (`Price * Consumption = Expenditure`)): If a quantity increases by `R%` (or fraction `a / b`), then to keep the product constant, the second quantity must decrease by `[R / (100 + R)] 100%` (*or fraction* `a / (a + b)`). *Conversely, if the first decreases by* `a / b`, *the second must increase by* `a / (b - a)`*.

Statement-II (Net Successive Percentage Change (`A-B` Formula)): Two successive changes of `x%` and `y%` produce a single net percentage change of `(x + y + (x y) / 100)%` (*use negative signs for decreases/discounts). For population or asset depreciation over* `n` *years at rate* `R%`: `Final Value = Initial` (1 + R/100)^n (growth) or `Initial * (1 - R/100)^n` (depreciation).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 2 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Same Selling Price (SP1 = SP2) with x% Profit on one and x% Loss on the other): Always results in an overall **Net Loss of (x^2 / 100)%**, and **Loss Amount = (2 *SP* (x/100)^2) / [1 - (x/100)^2]**.

Statement-II (Same Cost Price (CP1 = CP2) with x% Profit on one and x% Loss on the other): Overall result is **No Profit, No Loss (0%)**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 2 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Buy A Get B Free Scheme): **Effective Discount% = [B / (A + B)] * 100%**.

Statement-II (Simple Interest): **SI = (P *R* T) / 100**; **Amount A = P + SI**. If a sum becomes **n** times itself in **T** years at SI, then **(n - 1) = (R *T*) / 100**; *to become* ***m*** *times itself, time required* ***T*2 = [(*m* - 1) / (*n* - 1)]** T1.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 2 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (Compound Interest): **Amount A = P * (1 + R / 100)^n**; **CI = A - P**.

Statement-II (Half-Yearly Compounding): Rate becomes **R / 2** and time periods become **2n**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 2 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (Quarterly Compounding): Rate becomes **R / 4** and time periods become **4n**.

Statement-II (8-Monthly Compounding): Rate becomes **R (8/12) = (2/3)*R*** *and periods become* ***n*** (12/8).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 2 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Pascal's Triangle Tree Multipliers for CI): For **2 years** -> **2 : 1**; for **3 years** -> **3 : 3 : 1**; for **4 years** -> **4 : 6 : 4 : 1**.

Statement-II (SI Equal Annual Installment (x) for Debt A due in n years at R%): **Debt Due A = n*x* + [*x* R *n*(*n* - 1)] / (2 100)**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter *3:* Ratio & Proportion, Mixture-Alligation, Partnership & Averages

Chapter Key Study Pillars — Chapter 3: Ratio & Proportion, Mixture-Alligation, Partnership & Averages

Key Study Pillar 1
Ratio, Proportion, Componendo-Dividendo & Partnership

Key Study Pillar 2
Alligation, Repeated Replacement & Advanced Averages

3.1 Ratio, Proportion, Componendo-Dividendo & Partnership

- **Four Classical Proportions (for a : b :: c : d, where a *d* = *b* c):**
- **Mean Proportional** between **a** and **b**: **x = sqrt(a * b)**.

• **Third Proportional** to `a` and `b` (`a : b :: b : x`): `x = (b^2) / a`.

• **Fourth Proportional** to `a, b,` and `c` (`a : b :: c : x`): `x = (b * c) / a`.

• **Componendo and Dividendo:** If `a / b = c / d`, then `(a + b) / (a - b) = (c + d) / (c - d)`.

• **Equal Ratio Property:** If `a / b = c / d = e / f = k`, then `(a + c + e) / (b + d + f) = k` (provided denominator sum `!= 0`).

• **Income-Expenditure-Savings Cross-Product Method:** When `Income = Expenditure + Savings`, use `I1 : I2` and `E1 : E2` with individual savings `S1` and `S2`. By cross-multiplication:
`1 unit = |E2S1 - E1S2| / |I1E2 - I2E1|`.

• **Partnership Rule:** Profit is shared strictly in the ratio of the product of **Capital Invested and Time Duration**:

• `Profit_A : Profit_B : Profit_C = (C_A T_A) : (C_B T_B) : (C_C * T_C)`.

Step-by-Step Conceptual Process Flowchart

STEP 1 Place Cheaper (c) & Dearer (d) Values on Top

STEP 2 Place Mean Mixture Value (m) in Center

STEP 3 Take Cross-Differences |d - m| and |m - c|

STEP 4 Obtain Quantity Ratio q_c : q_d = (d - m) : (m - c)

Mixture / Average Scenario	Exact Mathematical Formula (Inline Notation)	Structural Application	Official Source
Rule of Alligation	`Quantity of Cheaper / Quantity of Dearer = (Dearer - Mean) / (Mean - Cheaper)`	Mixing two solutions, speeds, or profit rates	NCERT Textbooks
Repeated Dilution (`n` times)	`Final Pure Liquid = Initial Volume * [1 - (Replaced Vol / Initial Vol)]^n`	Drawing `x` liters of milk and replacing with water `n` times	SSC Exam Portal
Weighted Average	`Avg_w = (n1A1 + n2A2 + n3*A3) / (n1 + n2 + n3)`	Combining averages of multiple sub-groups	IUC Academy
Replacement in Average	`New Member Weight = Old Member Weight +/- (Total Count * Change in Avg)`	Use `+` if average increases; `-` if average decreases	SSC Exam Portal
Consecutive AP Series Avg	`Average = (First Term + Last Term) / 2 = Middle Term`	Adding `k` consecutive integers increases average by `k / 2`	NCERT Textbooks

3.2 Alligation, Repeated Replacement & Advanced Averages

• **What Alligation Ratio Represents:** When you alligate two derived rates (`A / B`), the resulting bottom ratio is **always the ratio of the denominators (`B1 : B2`)**!

• Alligating two **Speeds (`km / hr`)** gives the ratio of **Time (`hr1 : hr2`)**, NEVER distance!

• Alligating two **Profit Percentages (`Profit / CP`)** or **Selling Prices per kg** gives the ratio of **Cost Prices (`CP1 : CP2`)** or **Weights (`kg1 : kg2`)**.

• Alligating two **Concentrations (`Milk / Total Mixture`)** gives the ratio of **Total Mixture Volumes (`V1 : V2`)**.

• **Averages of Special Series & Cricket/Bowling Problems:**

• Average of first `n` natural numbers = `(n + 1) / 2` | Average of first `n` **even** natural numbers = `(n + 1)` | Average of first `n` **odd** natural numbers = `n`.

• **Cricket Batsman Average:** If a batsman scores `S` runs in the `n`-th innings, increasing his average by `k` runs, then `New Average (after n innings) = S - (n - 1) k` *and* `Old Average (after n-1 innings) = S - n` k.

• **Bowler Average:** `Bowling Average = Total Runs Conceded / Total Wickets Taken` (a lower bowling average is better!).

Did You Know?: If a vessel contains pure liquid `V`, and after `n` identical draw-and-replace operations the ratio of `Remaining Pure Liquid : Added Water` becomes `a : b`, then the fraction of liquid remaining is `a / (a + b)` (NOT `a / b`!), so `(1 - x/V)^n = a / (a + b)`.

Exam Trap Alert: When finding the **Third Proportional** to `12` and `18`, many candidates mistakenly take the average (`15`). The Third Proportional is `(b^2) / a = (18 * 18) / 12 = 27`! Also remember that when alligating two speeds (`40 km/h` and `60 km/h` with average speed `48 km/h`), the alligation ratio `(60 - 48) : (48 - 40) = 12 : 8 = 3 : 2` is the **ratio of time spent**, not distance traveled.

★ **Memory Trick:** For **Consecutive Numbers Average**, remember **"Add 1 Number -> Avg shifts by +0.5"**: every new consecutive integer appended to a sequence increases the average by `0.5` (and every new consecutive even or odd integer increases the average by `1.0`).

Chapter *3* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Ratio, Proportion, Componendo-Dividendo & Partnership	**Four Classical Proportions (for `a**	b :: c : d`, where` a *d* = *b* c`):**
Alligation, Repeated Replacement & Advanced Averages	**Mean Proportional**	between `a` and `b`: `x = sqrt(a * b)`.
Ratio, Proportion, Componendo-Dividendo & Partnership	**Third Proportional**	to `a` and `b` (`a : b :: b : x`): `x = (b^2) / a`.
Alligation, Repeated Replacement & Advanced Averages	**Fourth Proportional**	to `a, b,` and `c` (`a : b :: c : x`): `x = (b * c) / a`.
Ratio, Proportion, Componendo-Dividendo & Partnership	**Componendo and Dividendo**	If `a / b = c / d`, then `(a + b) / (a - b) = (c + d) / (c - d)`.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Alligation, Repeated Replacement & Advanced Averages	**Equal Ratio Property**	If **a / b = c / d = e / f = k**, then **(a + c + e) / (b + d + f) = k** (provided denominator sum **!= 0**).
Ratio, Proportion, Componendo-Dividendo & Partnership	**Income-Expenditure-Savings Cross-Product Method**	When **Income = Expenditure + Savings**, use **I1 : I2** and **E1 : E2** with individual savings **S1** and **S2**. By cross-multiplication: **1 unit = |E2*S1* - *E1S2*| / |I1*E2* - *I2*E1|**.
Alligation, Repeated Replacement & Advanced Averages	**Partnership Rule**	Profit is shared strictly in the ratio of the product of **Capital Invested and Time Duration**:
Ratio, Proportion, Componendo-Dividendo & Partnership	**`Profit_A**	Profit_B : Profit_C = (C_A *T_A*) : (*C_B* T_B) : (C_C * T_C)`.
Alligation, Repeated Replacement & Advanced Averages	**What Alligation Ratio Represents**	When you alligate two derived rates (**A / B**), the resulting bottom ratio is **always the ratio of the denominators (B1 : B2)**!
Ratio, Proportion, Componendo-Dividendo & Partnership	**Alligating two Speeds (km / hr) gives the ratio of Time (`hr1**	hr2`)**, NEVER distance!
Alligation, Repeated Replacement & Advanced Averages	**Cricket Batsman Average**	If a batsman scores **S** runs in the **n**-th innings, increasing his average by **k** runs, then **New Average (after n innings) = S - (n - 1) *k*** *and* ***Old Average (after n-1 innings) = S - n*** **k**.
Ratio, Proportion, Componendo-Dividendo & Partnership	**Bowler Average**	**Bowling Average = Total Runs Conceded / Total Wickets Taken** (a lower bowling average is better!).

Chapter *3* Multi-Statement Exam Verification Drills

Chapter 3 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Four Classical Proportions (for `a):** b :: c : d **, where** a *d* = *b* c`):

Statement-II (Mean Proportional): between **a** and **b**: **x = sqrt(a * b)**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 3 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Third Proportional): to **a** and **b** (**a : b :: b : x**): **x = (b^2) / a**.

Statement-II (Fourth Proportional): to **a, b,** and **c** (**a : b :: c : x**): **x = (b * c) / a**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 3 Statement-Verification Drill #3 Both Statements Verified Correct

Statement-I (Componendo and Dividendo): If `a / b = c / d`, then `(a + b) / (a - b) = (c + d) / (c - d)`.

Statement-II (Equal Ratio Property): If `a / b = c / d = e / f = k`, then `(a + c + e) / (b + d + f) = k` (provided denominator sum `!= 0`).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 3 Statement-Verification Drill #4 Both Statements Verified Correct

Statement-I (Income-Expenditure-Savings Cross-Product Method): When `Income = Expenditure + Savings`, use `I1 : I2` and `E1 : E2` with individual savings `S1` and `S2`. By cross-multiplication: `1 unit = |E2S1 - E1S2| / |I1E2 - I2E1|`.

Statement-II (Partnership Rule): Profit is shared strictly in the ratio of the product of **Capital Invested and Time Duration**:

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 3 Statement-Verification Drill #5 Both Statements Verified Correct

**Statement-I (`Profit_A):** Profit_B : Profit_C = (C_A *T_A*) : (*C_B* T_B) : (C_C * T_C)`.

Statement-II (What Alligation Ratio Represents): When you alligate two derived rates (`A / B`), the resulting bottom ratio is **always the ratio of the denominators (`B1 : B2`)**!

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 3 Statement-Verification Drill #6 Both Statements Verified Correct

Statement-I (Alligating two Speeds (`km / hr`) gives the ratio of Time (`hr1):** hr2`), NEVER distance!

Statement-II (Cricket Batsman Average): If a batsman scores `S` runs in the `n`-th innings, increasing his average by `k` runs, then `New Average (after n innings) = S - (n - 1) k` *and* `Old Average (after n-1 innings) = S - n` `k`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter *4:* Time & Work, Pipes & Cisterns, Time-Speed-Distance, Trains, Boats & Races

Chapter Key Study Pillars — Chapter *4*: Time & Work, Pipes & Cisterns, Time-Speed-Distance, Trains, Boats & Races

Key Study Pillar 1
Time & Work, Efficiency, Wages & Pipes and Cisterns

Key Study Pillar 2
Time, Speed & Distance, Trains, Boats & Streams, and Races

4.1 Time & Work, Efficiency, Wages & Pipes and Cisterns

• **LCM Total Work & Efficiency Framework:**

• `Total Work = Efficiency (Work/Day) * Time (Days)`. When total work is constant, **Efficiency is inversely proportional to Time** (`E1 : E2 = T2 : T1`).

• **Wages Distribution Rule:** Wages are always distributed in the **ratio of Total Work done by each person**; if all workers work for the exact same duration, wages are distributed in the **ratio of their Efficiencies (`E1 : E2 : E3`)**.

• **Two-Worker Shortcut:** If `A` takes `x` days MORE than `(A + B)` together, and `B` takes `y` days MORE than `(A + B)` together to complete a job, then `Time taken by (A + B) together = sqrt(x * y)` days!

• **MDH Chain Formula (Men-Days-Hours-Work):**

• `(M1 D1 H1 E1) / W1 = (M2 D2 H2 E2) / W2`, where `M` = number of workers, `D` = days, `H` = hours/day, `E` = individual efficiency, and `W` = work output (length of trench, consumption, wages earned).

• **"OR" vs "AND" Manpower Problems:** If `a1` Men OR `b1` Women finish a work in `D` days, then `a2` Men AND `b2` Women will finish the same work in `D / [(a2 / a1) + (b2 / b1)]` days.

• **Pipes and Cisterns:** Treat **Inlet Pipes** as positive efficiencies (`+E`) and **Outlet / Leak Pipes** as negative efficiencies (`-E`). In **Alternate Hour Problems** with a negative outlet pipe, always subtract the **maximum positive single-turn work** from Total Capacity first to find when the tank overflows/fills on the final turn without draining back!

Step-by-Step Conceptual Process Flowchart

STEP 1
Take LCM of Times as Total Work/Distance

STEP 2
Compute Individual Efficiencies or Speeds

STEP 3
Apply Relative Speed / Alternate Cycle Logic

STEP 4
Convert Units (5/18 vs 18/5) & Verify Time

Motion / Work Scenario	Exact Mathematical Formula (Inline Notation)	Key Unit & Direction Rule	Official Reference
Speed Unit Conversion	`1 km/hr = (5 / 18) m/s` ; `1 m/s = (18 / 5) km/hr`	Multiply by `5/18` for smaller unit (`m/s`)	NCERT Textbooks
Average Speed (Equal Distance)	`Avg Speed = (2 S1 S2) / (S1 + S2)` (Harmonic Mean)	For 3 equal legs: `3S1S2S3 / (S1S2 + S2S3 + S3S1)`	SSC Exam Portal
Late / Early Office Formula	`Distance D = [(S1 * S2) / ] * (Time Difference in hrs)`	S1 - S2	Sum time differences if one is Late and one is Early	IUC Academy
Radha-Shyam After-Meeting Theorem	`S1 / S2 = sqrt(t2 / t1)` ; `Meeting Time T = sqrt(t1 * t2)`	`t1, t2` are times taken **after crossing each other**	SSC Exam Portal
Boats & Streams	`Downstream D = u + v` ; `Upstream U = u - v`	`Boat Speed u = (D + U)/2` ; `Stream Speed v = (D - U)/2`	NCERT Textbooks

4.2 Time, Speed & Distance, Trains, Boats & Streams, and Races

• **Relative Speed & Train Crossing Mechanics:**

• **Opposite Direction:** `S_rel = S1 + S2` | **Same Direction:** `S_rel = |S1 - S2|`.

• **Train Crossing a Pole / Man / Tree (Negligible Length):** `Distance = Length of Train (L1)`.

• **Train Crossing a Bridge / Platform / Tunnel / Another Train (Length `L2`):** `Distance = L1 + L2` (lengths are **always added**, even when two trains move in the same direction!).

• **Stoppage Time per Hour:** `Stoppage Minutes per Hour = [(Speed without stoppages - Speed with stoppages) / Speed without stoppages] * 60`.

• **Linear & Circular Races:**

• In a race of length `L`, "*A beats B by* `x` *meters or* `t` *seconds*" means `B`**'s speed is** `x / t` **m/s**, and while `A` runs `L` meters, `B` runs `(L - x)` meters in the same time (`Speed_A : Speed_B = L : (L - x)`).

• **Circular Track Meeting (Track Length `L`, Speeds `S1, S2`):**

• **First Meeting Anywhere on Track:** `Time = L / S_rel` (`S1 + S2` for opposite direction; `|S1 - S2|` for same direction).

• **First Meeting at the Starting Point:** `Time = LCM of (L / S1, L / S2)`.

Did You Know?: When two runners with reduced integer speed ratio `a : b` (coprime, `a > b`) run continuously on a circular track from the same starting point at the same time, the number of **distinct meeting points** on the track is `(a - b)` if they run in the **same direction**, and `(a + b)` if they run in **opposite directions**!

Exam Trap Alert: In **Alternate Hour Pipe Problems** where Pipe A fills `+5 units/hr` and Leak B empties `-3 units/hr` on a `35-unit` tank, never divide `35 / 2 = 17.5 cycles (35 hrs)`! First subtract `+5` from `35` -> `30 units` take `30 / 2 = 15 cycles = 30 hours`, and on the `31st hour`, Pipe A adds `+5 units` to reach `35 units` in **31 hours**!

★ **Memory Trick:** For unit conversion between `km/h` and `m/s`, remember `18` **is big (** `km/h` **) and** `5` **is small (** `m/s` **)**: to go to the small unit (`m/s`), put `5` on top (`5/18`); *to go to the big unit (* `km/h` *), put* `18` *on top (*`18/5`).

Chapter 4 Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Time & Work, Efficiency, Wages & Pipes and Cisterns	**Wages Distribution Rule**	Wages are always distributed in the **ratio of Total Work done by each person**; if all workers work for the exact same duration, wages are distributed in the **ratio of their Efficiencies (`E1 : E2 : E3`)**.
Time, Speed & Distance, Trains, Boats & Streams, and Races	**Two-Worker Shortcut**	If `A` takes `x` days MORE than `(A + B)` together, and `B` takes `y` days MORE than `(A + B)` together to complete a job, then `Time taken by (A + B) together = sqrt(x * y)` days!
Time & Work, Efficiency, Wages & Pipes and Cisterns	**"OR" vs "AND" Manpower Problems**	If `a1` Men OR `b1` Women finish a work in `D` days, then `a2` Men AND `b2` Women will finish the same work in `D / [(a2 / a1) + (b2 / b1)]` days.
Time, Speed & Distance, Trains, Boats & Streams, and Races	**Pipes and Cisterns**	Treat **Inlet Pipes** as positive efficiencies (`+E`) and **Outlet / Leak Pipes** as negative efficiencies (`-E`). In **Alternate Hour Problems** with a negative outlet pipe, always subtract the **maximum positive single-turn work** from Total Capacity first to find when the tank overflows/fills on the final turn without draining back!

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Time & Work, Efficiency, Wages & Pipes and Cisterns	Opposite Direction	`S_rel = S1 + S2` | Same Direction: `S_rel = |S1 - S2|`.
Time, Speed & Distance, Trains, Boats & Streams, and Races	Train Crossing a Pole / Man / Tree (Negligible Length)	`Distance = Length of Train (L1)`.
Time & Work, Efficiency, Wages & Pipes and Cisterns	Train Crossing a Bridge / Platform / Tunnel / Another Train (Length `L2`)	`Distance = L1 + L2` (lengths are **always added**, even when two trains move in the same direction!).
Time, Speed & Distance, Trains, Boats & Streams, and Races	Stoppage Time per Hour	`Stoppage Minutes per Hour = [(Speed without stoppages - Speed with stoppages) / Speed without stoppages] * 60`.
Time & Work, Efficiency, Wages & Pipes and Cisterns	First Meeting Anywhere on Track	`Time = L / S_rel` (`S1 + S2` for opposite direction; `|S1 - S2|` for same direction).
Time, Speed & Distance, Trains, Boats & Streams, and Races	First Meeting at the Starting Point	`Time = LCM of (L / S1, L / S2)`.

Chapter 4 Multi-Statement Exam Verification Drills

Chapter 4 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Wages Distribution Rule): Wages are always distributed in the **ratio of Total Work done by each person**; if all workers work for the exact same duration, wages are distributed in the **ratio of their Efficiencies (`E1 : E2 : E3`)**.

Statement-II (Two-Worker Shortcut): If `A` takes `x` days MORE than `(A + B)` together, and `B` takes `y` days MORE than `(A + B)` together to complete a job, then `Time taken by (A + B) together = sqrt(x * y)` days!

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 4 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I ("OR" vs "AND" Manpower Problems): If `a1` Men OR `b1` Women finish a work in `D` days, then `a2` Men AND `b2` Women will finish the same work in `D / [(a2 / a1) + (b2 / b1)]` days.

Statement-II (Pipes and Cisterns): Treat **Inlet Pipes** as positive efficiencies (`+E`) and **Outlet / Leak Pipes** as negative efficiencies (`-E`). In **Alternate Hour Problems** with a negative outlet pipe, always subtract the **maximum positive single-turn work** from Total Capacity first to find when the tank overflows/fills on the final turn without draining back!

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 4 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Opposite Direction): `S_rel = S1 + S2` | **Same Direction:** `S_rel = |S1 - S2|`.
Statement-II (Train Crossing a Pole / Man / Tree (Negligible Length)): `Distance = Length of Train (L1)`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 4 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (Train Crossing a Bridge / Platform / Tunnel / Another Train (Length `L2`)): `Distance = L1 + L2` (lengths are **always added**, even when two trains move in the same direction!).
Statement-II (Stoppage Time per Hour): `Stoppage Minutes per Hour = [(Speed without stoppages - Speed with stoppages) / Speed without stoppages] * 60`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 4 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (First Meeting Anywhere on Track): `Time = L / S_rel` (`S1 + S2` for opposite direction; `|S1 - S2|` for same direction).
Statement-II (First Meeting at the Starting Point): `Time = LCM of (L / S1, L / S2)`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter *5*: Algebra — Polynomials, Quadratic Equations & High-Speed Identities

Chapter Key Study Pillars — Chapter 5: Algebra — Polynomials, Quadratic Equations & High-Speed Identities

Key Study Pillar 1
Core Algebraic Identities & Gauss's 3-Variable Cubic Identity

Key Study Pillar 2
Quadratic Equations, Nature of Roots & Maxima-Minima

5.1 Core Algebraic Identities & Gauss's *3*-Variable Cubic Identity

- **Fundamental Square & Cube Expansions:**
- `(a + b)^2 = a^2 + b^2 + 2ab` | `(a - b)^2 = a^2 + b^2 - 2ab`.
- `(a + b)^2 + (a - b)^2 = 2(a^2 + b^2)` | `(a + b)^2 - (a - b)^2 = 4ab`.
- `(a + b + c)^2 = a^2 + b^2 + c^2 + 2(ab + bc + ca)`.
- `(a + b)^3 = a^3 + b^3 + 3ab(a + b)` | `(a - b)^3 = a^3 - b^3 - 3ab(a - b)`.
- `a^3 + b^3 = (a + b)(a^2 - ab + b^2) = (a + b)[(a + b)^2 - 3ab]`.
- `a^3 - b^3 = (a - b)(a^2 + ab + b^2) = (a - b)[(a - b)^2 + 3ab]`.
- `a^4 + a^2*b^2 + b^4 = (a^2 + ab + b^2)(a^2 - ab + b^2)`.
- **Master 3-Variable Cubic Identity (Tested in Every SSC CGL Shift):**
- `a^3 + b^3 + c^3 - 3abc = (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca)`
- **Form 2 (When `a, b, c` are close integers like `999, 1000, 1001`):**

`a^3 + b^3 + c^3 - 3abc = (1 / 2) (a + b + c) [(a - b)^2 + (b - c)^2 + (c - a)^2]`.

- **Form 3:** `a^3 + b^3 + c^3 - 3abc = (a + b + c) * [(a + b + c)^2 - 3(ab + bc + ca)]`.
- **Zero Condition:** `a^3 + b^3 + c^3 = 3abc` holds **if and only if** `(a + b + c = 0)` **OR** `(a = b = c)`.

Step-by-Step Conceptual Process Flowchart

STEP 1 Identify Given Reciprocal Sum (x + 1/x = k)

STEP 2 Compute Square & Cube Powers (k^2 - 2, k^3 - 3k)

STEP 3 Convert Sign if Needed via sqrt(k^2 +/- 4)

STEP 4 Combine Powers for x^5, x^6 or x^7

Given Reciprocal Condition	Derived Target Expression	Exact Formula in Terms of `k`	Official Reference
`x + 1/x = k`	`x^2 + 1/x^2` and `x^3 + 1/x^3`	`k^2 - 2` and `k^3 - 3k`	SSC Exam Portal
`x - 1/x = k`	`x^2 + 1/x^2` and `x^3 - 1/x^3`	`k^2 + 2` and `k^3 + 3k`	NCERT Textbooks
`x + 1/x = k` <-> `x - 1/x`	Sign Flip Bridge Formula	`x - 1/x = +/- sqrt(k^2 - 4)` ; `x + 1/x = +/- sqrt(k^2 + 4)`	IUC Academy
`x + 1/x = k`	`x^4 + 1/x^4` and `x^5 + 1/x^5`	`(k^2 - 2)^2 - 2` and `(x^2 + 1/x^2)(x^3 + 1/x^3) - (x + 1/x)`	SSC Exam Portal
`x + 1/x = 2` **or** `-2`	Special Fixed Roots	`k = 2 => x = 1` ; `k = -2 => x = -1`	IUC Academy
`x + 1/x = 1` **or** `sqrt(3)`	Cyclotomic Power Reduction	`k = 1 => x^3 = -1` (`k = -1 => x^3 = +1`) ; `k = sqrt(3) => x^6 = -1`	SSC Exam Portal

5.2 Quadratic Equations, Nature of Roots & Maxima-Minima

- **Quadratic Equation (** `ax^2 + bx + c = 0` **, where** `a != 0` **):**
- **Roots (** `alpha, beta` **):** `x = [-b +/- sqrt(b^2 - 4ac)] / (2a)`.
- **Sum of Roots:** `alpha + beta = -b / a` | **Product of Roots:** `alpha * beta = c / a` | **Difference of Roots:** `|alpha - beta| = sqrt(b^2 - 4ac) / |a|`.
- **Reconstructing Equation from Roots:** `x^2 - (Sum of Roots)*x + (Product of Roots) = 0`.
- **Discriminant (** `D = b^2 - 4ac` **):**
- `D > 0`: Real and unequal (distinct) roots (if `D` is a perfect square and `a, b, c` are rational, roots are rational).
- `D = 0`: Real and equal roots (`-b / 2a`).
- `D < 0`: Complex conjugate (imaginary) roots (`p +/- i*q`).
- **Maximum / Minimum Value of** `ax^2 + bx + c` **:**Occurs at `x = -b / (2a)`, and the extreme value is `(4ac - b^2) / (4a)` (Minimum if `a > 0`; Maximum if `a < 0`).
- **System of Linear Equations (** `a1x + b1y + c1 = 0` **and** `a2x + b2y + c2 = 0` **):**
- **Unique Solution (Intersecting Lines — Consistent):** `a1 / a2 != b1 / b2`.

- **No Solution (Parallel Lines — Inconsistent):** `a1 / a2 = b1 / b2 != c1 / c2`.
- **Infinitely Many Solutions (Coincident Lines — Dependent Consistent):** `a1 / a2 = b1 / b2 = c1 / c2`.

Did You Know?: Whenever a sum of squares of real expressions equals zero—such as `(x - a)^2 + (y - b)^2 + (z - c)^2 = 0`—every individual squared term must independently equal zero, giving `x = a`, `y = b`, and `z = c` immediately without solving simultaneous equations!

Exam Trap Alert: When computing `x^5 - 1/x^5`, carefully match the factors: `x^5 - 1/x^5 = (x^2 + 1/x^2)(x^3 - 1/x^3) - (x - 1/x)` (one factor must be `+` and one factor must be `-`, subtracting `(x - 1/x)` at the end!).

★ **Memory Trick:** Memorize the **3 Special Values of** `x + 1/x`: `2` **gives** `x = 1`, `1` **gives** `x^3 = -1`, and `sqrt(3)` **gives** `x^6 = -1` (so any pair of powers differing by `6`, like `x^24 + x^18`, cancels to `0`!).

Chapter *5* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Core Algebraic Identities & Gauss's 3-Variable Cubic Identity	**Form 3**	`a^3 + b^3 + c^3 - 3abc = (a + b + c) * [(a + b + c)^2 - 3(ab + bc + ca)]`.
Quadratic Equations, Nature of Roots & Maxima-Minima	**Zero Condition**	`a^3 + b^3 + c^3 = 3abc` holds **if and only if** `(a + b + c = 0)` **OR** `(a = b = c)`.
Core Algebraic Identities & Gauss's 3-Variable Cubic Identity	**Roots (`alpha, beta`)**	`x = [-b +/- sqrt(b^2 - 4ac)] / (2a)`.
Quadratic Equations, Nature of Roots & Maxima-Minima	**Sum of Roots**	`alpha + beta = -b / a` | **Product of Roots:** `alpha * beta = c / a` | **Difference of Roots:** `|alpha - beta| = sqrt(b^2 - 4ac) / |a|`.
Core Algebraic Identities & Gauss's 3-Variable Cubic Identity	**Reconstructing Equation from Roots**	`x^2 - (Sum of Roots)*x + (Product of Roots) = 0`.
Quadratic Equations, Nature of Roots & Maxima-Minima	`D > 0`	Real and unequal (distinct) roots (if `D` is a perfect square and `a, b, c` are rational, roots are rational).
Core Algebraic Identities & Gauss's 3-Variable Cubic Identity	`D = 0`	Real and equal roots (`-b / 2a`).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Quadratic Equations, Nature of Roots & Maxima-Minima	`D < 0`	Complex conjugate (imaginary) roots (`p +/- i*q`).
Core Algebraic Identities & Gauss's 3-Variable Cubic Identity	Maximum / Minimum Value of `ax^2 + bx + c`	Occurs at `x = -b / (2a)`, and the extreme value is `(4ac - b^2) / (4a)`** (Minimum if `a > 0`; Maximum if `a < 0`).
Quadratic Equations, Nature of Roots & Maxima-Minima	Unique Solution (Intersecting Lines — Consistent)	`a1 / a2 != b1 / b2` .
Core Algebraic Identities & Gauss's 3-Variable Cubic Identity	No Solution (Parallel Lines — Inconsistent)	`a1 / a2 = b1 / b2 != c1 / c2` .
Quadratic Equations, Nature of Roots & Maxima-Minima	Infinitely Many Solutions (Coincident Lines — Dependent Consistent)	`a1 / a2 = b1 / b2 = c1 / c2` .

Chapter 5 Multi-Statement Exam Verification Drills

Chapter 5 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Form 3): `a^3 + b^3 + c^3 - 3abc = (a + b + c) * [(a + b + c)^2 - 3(ab + bc + ca)]` .

Statement-II (Zero Condition): `a^3 + b^3 + c^3 = 3abc` holds **if and only if** `(a + b + c = 0)` **OR** `(a = b = c)` .

✔ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 5 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Roots (`alpha, beta`)): `x = [-b +/- sqrt(b^2 - 4ac)] / (2a)` .

Statement-II (Sum of Roots): `alpha + beta = -b / a` | **Product of Roots:** `alpha * beta = c / a` | **Difference of Roots:** `|alpha - beta| = sqrt(b^2 - 4ac) / |a|` .

✔ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 5 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Reconstructing Equation from Roots): `x^2 - (Sum of Roots)*x + (Product of Roots) = 0` .

Statement-II (`D > 0`): Real and unequal (distinct) roots (if `D` is a perfect square and `a, b, c` are rational, roots are rational).

✔ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 5 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (`D = 0`): Real and equal roots (`-b / 2a`).
Statement-II (`D < 0`): Complex conjugate (imaginary) roots (`p +/- i*q`).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 5 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (Maximum / Minimum Value of `ax^2 + bx + c`): Occurs at `x = -b / (2a)`, and the extreme value is `(4ac - b^2) / (4a)` (Minimum if `a > 0`; Maximum if `a < 0`).
Statement-II (Unique Solution (Intersecting Lines — Consistent)): `a1 / a2 != b1 / b2`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 5 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (No Solution (Parallel Lines — Inconsistent)): `a1 / a2 = b1 / b2 != c1 / c2`.
Statement-II (Infinitely Many Solutions (Coincident Lines — Dependent Consistent)): `a1 / a2 = b1 / b2 = c1 / c2`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter *6:* Trigonometry, Trigonometric Identities, Maxima-Minima & Heights and Distances

Chapter Key Study Pillars — Chapter 6: Trigonometry, Trigonometric Identities, Maxima-Minima & Heights and Distances

Key Study Pillar 1
Trigonometric Ratios, Radian Measure, Quadrant Signs & Complementary Identities

Key Study Pillar 2
Compound-Angle Identities & Heights and Distances Shortcuts

6.1 Trigonometric Ratios, Radian Measure, Quadrant Signs & Complementary Identities

• **Radian-Degree Conversion & Arc Length: `pi radians = 180 degrees`** (**`1 radian = 180/pi degrees`** ~ **`57 deg 16 min 22 sec`**). Arc length **`l = r *theta*`** (*with* **`theta`** *in radians), and Sector Area* **`A = (1/2)`**(r^2) *theta* = (1/2) l * r.

• **Pythagorean Fundamental Identities & Conjugates:**

1. **`sin^2(theta) + cos^2(theta) = 1`**.
2. **`sec^2(theta) - tan^2(theta) = 1`** => **`(sec(theta) + tan(theta))(sec(theta) - tan(theta)) = 1`**. Thus, **if `sec(theta) + tan(theta) = k`, then `sec(theta) - tan(theta) = 1 / k`**, which immediately gives **`sec(theta) = (k^2 + 1) / (2k)`**, **`tan(theta) = (k^2 - 1) / (2k)`**, and **`sin(theta) = (k^2 - 1) / (k^2 + 1)`**!
3. **`cosec^2(theta) - cot^2(theta) = 1`** => **if `cosec(theta) + cot(theta) = k`, then `cosec(theta) - cot(theta) = 1 / k`**.

• **ASTC Quadrant Rule & Complementary Pairs (`A + B = 90 deg`):**

• **Quadrant I (`0–90 deg`):** All positive | **Quadrant II (`90–180 deg`):** Sin & Cosec positive | **Quadrant III (`180–270 deg`):** Tan & Cot positive | **Quadrant IV (`270–360 deg`):** Cos & Sec positive.

• When A + B = 90 deg, sin A = cos B, tan A = cot B, sec A = cosec B, so tan A *tan B* = 1, *cot A* cot B = 1, sin^2(A) + sin^2(B) = 1, and cos^2(A) + cos^2(B) = 1.

Step-by-Step Conceptual Process Flowchart

STEP 1
Check Complementary Sum (A + B = 90 or 45)

STEP 2
Apply Conjugate Reciprocal (sec + tan = k)

STEP 3
Substitute Non-Degenerate Angle (45 or 30/60)

STEP 4
Apply 30-60-90 Triangle Ratios in Height-Distance

Trigonometric Expression / Condition	Exact Simplified Result / Extreme Value	Governing Identity / Constraint	Official Source
a*sin(theta)* + *b*cos(theta)	Max = +sqrt(a^2 + b^2); Min = -sqrt(a^2 + b^2)	Holds for all real a, b	SSC Exam Portal
a*tan*^2(*theta*) + *b*cot^2(theta)	Minimum Value = 2 *sqrt*(*a* b)	By AM-GM Inequality (a, b > 0)	IUC Academy
a*sec*^2(*theta*) + *b*cosec^2(theta)	Minimum Value = (sqrt(a) + sqrt(b))^2	equals a + b + 2*sqrt(ab)	SSC Exam Portal
A + B = 45 deg (or 225 deg)	(1 + tan A)(1 + tan B) = 2 and (cot A - 1)(cot B - 1) = 2	Derived from tan(A + B) = 1	NCERT Textbooks
Triple-Angle Product Identity	sin(theta) *sin*(60 - *theta*) sin(60 + theta) = (1 / 4) *sin*(3theta)	Also holds for cos (1/4 cos 3*theta*) & *tan* (*tan* 3theta)	IUC Academy

6.2 Compound-Angle Identities & Heights and Distances Shortcuts

• **Compound & Double Angle Formulas:**

• sin(A +/- B) = sin A cos B +/- cos A sin B | cos(A +/- B) = cos A cos B -/+ sin A sin B.

• tan(A +/- B) = (tan A +/- tan B) / (1 -/+ tan A tan B).

• sin(2A) = 2 sin A cos A = (2 tan A) / (1 + tan^2 A) | cos(2A) = cos^2 A - sin^2 A = 2 cos^2 A - 1 = 1 - 2 sin^2 A = (1 - tan^2 A) / (1 + tan^2 A).

• sin(15 deg) = cos(75 deg) = (sqrt(3) - 1) / (2*sqrt*(2)) | *cos*(15 *deg*) = *sin*(75 *deg*) = (*sqrt*(3) + 1) / (2 sqrt(2)) | tan(15 deg) = cot(75 deg) = 2 - sqrt(3) | tan(75 deg) = cot(15 deg) = 2 + sqrt(3).

• **Heights and Distances Triangle Ratios & Formulae:**

• 30 deg - 60 deg - 90 deg **Right Triangle:** Sides opposite to 30 deg : 60 deg : 90 deg are strictly in the ratio 1 : sqrt(3) : 2.

• 45 deg - 45 deg - 90 deg **Right Triangle:** Sides opposite to 45 deg : 45 deg : 90 deg are in the ratio 1 : 1 : sqrt(2).

• 15 deg - 75 deg - 90 deg **Right Triangle:** Sides opposite to 15 deg : 75 deg : 90 deg are in the ratio (sqrt(3) - 1) : (sqrt(3) + 1) : 2*sqrt(2).

• **Two-Point Shadow / Observation Formula:** When the angle of elevation of a tower of height H changes from theta1 to theta2 (theta1 < theta2) on walking a distance d toward the base along the horizontal

plane: **d = H (*cot(theta1) - cot(theta2)*)**. *Specifically, for* **30 deg** *to* **60 deg**, ***d = H*** (sqrt(3) - 1/sqrt(3)) = (2 / sqrt(3)) *H, so* ***H* = (*sqrt*(3) / 2)** **d**!

• **Complementary Elevation Angles (theta and 90 - theta):** If the angles of elevation of the top of a tower from two points at distances **a** and **b** from its base are complementary (**theta** and **90 - theta**), then **Height of Tower H = sqrt(a * b)**.

Did You Know?: If ***a*sin(*theta*) + *b*cos(theta) = c** and ***a*cos(*theta*) - *b*sin(theta) = x**, squaring and adding both equations eliminates **theta** completely and yields the universal invariant **a^2 + b^2 = c^2 + x^2**. Specifically, when **c = sqrt(a^2 + b^2)**, then **x = 0** and **sin(theta) = a / c**, **cos(theta) = b / c**!

Exam Trap Alert: For ***a*sin^2(*theta*) + *b*cos^2(theta)**, do NOT use **2*sqrt(ab)**! Because **sin^2(theta) + cos^2(theta) = 1** is a convex linear combination, the **Maximum value is simply max(a, b)** and the **Minimum value is min(a, b)**!

★ **Memory Trick:** Remember the **30 deg -> 60 deg** **Shadow Ratio**: the distance from the **60 deg** point to the tower base (**1 unit**) is **exactly half** the distance walked between the **30 deg** and **60 deg** points (**2 units**)!

Chapter *6* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Trigonometric Ratios, Radian Measure, Quadrant Signs & Complementary Identities	**Radian-Degree Conversion & Arc Length**	**pi radians = 180 degrees** (**1 radian = 180/pi degrees** ~ **57 deg 16 min 22 sec**). Arc length **l = r *theta*** (*with* ***theta*** *in radians), and Sector Area* ***A* = (1/2)** (r^2) *theta* = (1/2) l * r.
Compound-Angle Identities & Heights and Distances Shortcuts	**Quadrant I (0–90 deg)**	**A**ll positive | **Quadrant II (90–180 deg): S**in & Cosec positive | **Quadrant III (180–270 deg): T**an & Cot positive | **Quadrant IV (270–360 deg): C**os & Sec positive.
Trigonometric Ratios, Radian Measure, Quadrant Signs & Complementary Identities	**30 deg - 60 deg - 90 deg Right Triangle**	Sides opposite to **30 deg : 60 deg : 90 deg** are strictly in the ratio **1 : sqrt(3) : 2**.
Compound-Angle Identities & Heights and Distances Shortcuts	**45 deg - 45 deg - 90 deg Right Triangle**	Sides opposite to **45 deg : 45 deg : 90 deg** are in the ratio **1 : 1 : sqrt(2)**.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Trigonometric Ratios, Radian Measure, Quadrant Signs & Complementary Identities	15 deg - 75 deg - 90 deg Right Triangle	Sides opposite to 15 deg : 75 deg : 90 deg are in the ratio (sqrt(3) - 1) : (sqrt(3) + 1) : 2*sqrt(2).
Compound-Angle Identities & Heights and Distances Shortcuts	Two-Point Shadow / Observation Formula	When the angle of elevation of a tower of height H changes from theta1 to theta2 (theta1 < theta2) on walking a distance d toward the base along the horizontal plane: d = H (*cot(theta1) - cot(theta2)*). *Specifically, for* 30 deg *to* 60 deg, *d = H* (sqrt(3) - 1/sqrt(3)) = (2 / sqrt(3)) *H, so* *H = (sqrt(3) / 2)* d!
Trigonometric Ratios, Radian Measure, Quadrant Signs & Complementary Identities	Complementary Elevation Angles (theta and 90 - theta)	If the angles of elevation of the top of a tower from two points at distances a and b from its base are complementary (theta and 90 - theta), then Height of Tower H = sqrt(a * b).

Chapter *6* Multi-Statement Exam Verification Drills

Chapter 6 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Radian-Degree Conversion & Arc Length): pi radians = 180 degrees (1 radian = 180/pi degrees ~ 57 deg 16 min 22 sec). Arc length l = r *theta* (*with* *theta* *in radians*), *and Sector Area* *A* = (1/2)(r^2) *theta* = (1/2) l * r.

Statement-II (Quadrant I (0–90 deg)): All positive | **Quadrant II (90–180 deg):** Sin & Cosec positive | **Quadrant III (180–270 deg):** Tan & Cot positive | **Quadrant IV (270–360 deg):** Cos & Sec positive.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 6 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (30 deg - 60 deg - 90 deg Right Triangle): Sides opposite to 30 deg : 60 deg : 90 deg are strictly in the ratio 1 : sqrt(3) : 2.

Statement-II (45 deg - 45 deg - 90 deg Right Triangle): Sides opposite to 45 deg : 45 deg : 90 deg are in the ratio 1 : 1 : sqrt(2).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 6 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (15 deg - 75 deg - 90 deg Right Triangle): Sides opposite to 15 deg : 75 deg : 90 deg are in the ratio (sqrt(3) - 1) : (sqrt(3) + 1) : 2*sqrt(2).

Statement-II (Two-Point Shadow / Observation Formula): When the angle of elevation of a tower of height H changes from theta1 to theta2 (theta1 < theta2) on walking a distance d toward the base along the horizontal plane: d = H (*cot(theta1) - cot(theta2)*). *Specifically, for* 30 deg *to* 60 deg, *d = H* (sqrt(3) - 1/sqrt(3)) = (2 / sqrt(3)) *H, so* *H = (sqrt(3) / 2)* d!

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 7: Geometry (Triangles, Centers, Similarity, Circles & Polygons) & Coordinate Geometry

Chapter Key Study Pillars — Chapter 7: Geometry (Triangles, Centers, Similarity, Circles & Polygons) & Coordinate Geometry

Key Study Pillar 1
Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity

Key Study Pillar 2
Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry

7.1 Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity

• **Convex Polygon Formulas (for an `n`-sided Polygon):**

• Sum of all Interior Angles = **`(n - 2) 180 deg`** | *Each Interior Angle of a Regular Polygon* = **`[(n - 2)`** 180 deg] / n.

• Sum of all Exterior Angles = **`360 deg`** (constant for every convex polygon!) | Each Exterior Angle of a Regular Polygon = **`360 deg / n`** (Note: **`Interior Angle + Exterior Angle = 180 deg`**).

• Number of Diagonals = **`n(n - 3) / 2`**.

• **Triangle Properties & Sine / Cosine / Stewart / Apollonius Theorems:**

• For sides **`a, b, c`**: **`|a - b| < c < (a + b)`**. If **`c`** is the largest side: **`a^2 + b^2 > c^2`** (**Acute Triangle**), **`a^2 + b^2 = c^2`** (**Right Triangle**), and **`a^2 + b^2 < c^2`** (**Obtuse Triangle**).

• **Sine Rule:** **`a / sin A = b / sin B = c / sin C = 2R`** (where **`R`** is the Circumradius).

• **Cosine Rule:** **`cos A = (b^2 + c^2 - a^2) / (2bc)`**.

• **Apollonius Median Theorem (for Median `AD` to side `BC = a`):** **`AB^2 + AC^2 = 2(AD^2 + BD^2)`**, which gives **`Median length m_a = (1 / 2) sqrt(2b^2 + 2c^2 - a^2)`**. *Also,* **`(3/4)`** (Sum of Perimeter Sides) < Sum of Medians < Perimeter, and **`3 (AB^2 + BC^2 + CA^2) = 4 (AD^2 + BE^2 + CF^2)`**, and **`Area of Triangle = (4 / 3) * Area of Triangle formed by its 3 Medians`**.

Step-by-Step Conceptual Process Flowchart

STEP 1
Identify Center Type (I, O, G, H)

STEP 2
Apply Angle Bisector / Chord / Tangent Theorem

STEP 3
Scale Areas by Square of Similarity Ratio

STEP 4
Compute Coordinates, Slope or Circle Radius

Triangle Center	Intersection Of	Key Angle Formula (at Center for Apex `A`)	Special Radius & Geometric Property	Official Reference
Incenter (`I`)	**3 Internal Angle Bisectors**	**`Angle BIC = 90 deg + (A / 2)`** (External: **`90 - A/2`**)	Equidistant from **3 Sides**; **`r = Area / s`** (Right Triangle: **`r = (P + B - H) / 2`**)	NCERT Textbooks
Circumcenter (`O`)	**3 Perpendicular Bisectors of Sides**	**`Angle BOC = 2 * A`**	Equidistant from **3 Vertices**; **`R = (abc) / (4 * Area)`** (Right Triangle: **`R = H / 2`** at hypotenuse midpoint)	SSC Exam Portal

Triangle Center	Intersection Of	Key Angle Formula (at Center for Apex A)	Special Radius & Geometric Property	Official Reference
Centroid (G)	**3 Medians** (Vertex to Midpoint)	Divides each median in **2 : 1** ratio; divides triangle into **6 equal areas**	Coordinates **G = ((x1+x2+x3)/3, (y1+y2+y3)/3)**	IUC Academy
Orthocenter (H)	**3 Altitudes**	**Angle BHC = 180 deg - A** (**Angle BHC + A = 180 deg**)	In a Right Triangle, **H** lies exactly at the **90 deg** vertex! Euler Line: **HG : GO = 2 : 1**	SSC Exam Portal

7.2 Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry

• **Thales Theorem (BPT), Angle Bisector Theorem & Similarity:**

• **Angle Bisector Theorem:** If **AD** bisects **Angle A** meeting **BC** at **D**, then **AB / AC = BD / DC**, and length of internal angle bisector **AD^2 = AB *AC* - *BD* DC**.

• **Similar Triangles (Triangle ABC ~ Triangle PQR):** Ratio of corresponding sides = Ratio of Perimeters = Ratio of Altitudes/Medians/Inradii/Circumradii = **k**, while **Ratio of Areas = k^2 (Square of ratio of corresponding sides)**.

• **Right-Angle Altitude Theorem (Right-angled at B, with BD perpendicular to hypotenuse AC): BD = (AB *BC*) / *AC***, ***BD*^2 = *AD*** DC, **AB^2 = AD *AC***, *and* ***BC*^2 = *CD*** AC.

• **Master Circle Theorems:**

• Angle subtended by an arc at the center is **twice** the angle subtended at any point on the remaining circumference (**Angle AOB = 2 * Angle ACB**); angle in a **semicircle is 90 deg**.

• **Cyclic Quadrilateral:** Opposite angles are supplementary (**A + C = 180 deg**, **B + D = 180 deg**). **Ptolemy's Theorem: AC *BD* = (*AB* CD) + (BC * AD)**.

• **Intersecting Chords (AB and CD intersecting at P inside or outside as Secants): PA *PB* = *PC* PD**.

• **Tangent-Secant Theorem (PT is tangent and PAB is secant): PT^2 = PA * PB**.

• **Alternate Segment Theorem:** Angle between a tangent and a chord through the point of contact equals the angle subtended by the chord in the alternate segment.

• **Direct & Transverse Common Tangents (Centers distance d, Radii r1, r2):**

• **L_DCT = sqrt[d^2 - (r1 - r2)^2]** (When two circles touch externally, **d = r1 + r2**, so **L_DCT = 2 *sqrt*(*r*1 r2)**!).

• **L_TCT = sqrt[d^2 - (r1 + r2)^2]**.

• **Coordinate Geometry Essentials:**

• **Distance Formula: d = sqrt[(x2 - x1)^2 + (y2 - y1)^2]** | **Section Formula (m : n): ((m*x*2 + *n*x1)/(m + n), (m*y*2 + *n*y1)/(m + n))**.

• **Area of Triangle with Vertices (x1, y1), (x2, y2), (x3, y3): (1 / 2) * |x1(y2 - y3) + x2(y3 - y1) + x3(y1 - y2)|**.

• **Slope (m = (y2 - y1)/(x2 - x1) = -a/b for ax + by + c = 0):** Parallel lines have **m1 = m2**; Perpendicular lines have **m1 * m2 = -1**.

• **Perpendicular Distance from Point** `(x1, y1)` **to Line** `ax + by + c = 0` **:** `d = |ax1 + by1 + c| / sqrt(a^2 + b^2)`.

• **Reflection Rules:** Reflection of `(x, y)` in **X-axis** is `(x, -y)`; in **Y-axis** is `(-x, y)`; in **Origin** is `(-x, -y)`; in line `y = k` is `(x, 2k - y)`; in line `x = k` is `(2k - x, y)`.

Did You Know?: In any non-equilateral triangle, the **Orthocenter (** `H` **), Centroid (** `G` **), and Circumcenter (** `O` **)** are always collinear on the **Euler Line**, with the Centroid dividing the segment between Orthocenter and Circumcenter in the exact ratio `HG : GO = 2 : 1`!

Exam Trap Alert: Do not confuse the angle at the **Incenter (** `90 + A/2` **)**, the **External Bisector Intersection (** `90 - A/2` **)**, the **Circumcenter (** `2A` **)**, and the **Orthocenter (** `180 - A` **)**! Also, in a Right-Angled Triangle (`P, B, H`), the distance between the **Orthocenter (** `90 deg` **vertex) and Circumcenter (midpoint of hypotenuse)** is simply equal to the **Circumradius** `R = H / 2`!

★ **Memory Trick:** For **Right Triangle Radii**, remember `r = (P + B - H) / 2` and `R = H / 2`, which also gives the golden sum `r + 2R = P + B`!

Chapter 7 Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity	**For sides** `a, b, c`	`|a - b| < c < (a + b)`. If `c` is the largest side: `a^2 + b^2 > c^2` **(Acute Triangle)**, `a^2 + b^2 = c^2` **(Right Triangle)**, and `a^2 + b^2 < c^2` **(Obtuse Triangle)**.
Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry	**Sine Rule**	`a / sin A = b / sin B = c / sin C = 2R` (where `R` is the Circumradius).
Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity	**Cosine Rule**	`cos A = (b^2 + c^2 - a^2) / (2bc)`.
Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry	**Apollonius Median Theorem (for Median** `AD` **to side** `BC = a` **)**	`AB^2 + AC^2 = 2(AD^2 + BD^2)`, which gives `Median length m_a = (1 / 2) sqrt(2b^2 + 2c^2 - a^2)`. *Also,* `(3/4)` (Sum of Perimeter Sides) < Sum of Medians < Perimeter, and `3 (AB^2 + BC^2 + CA^2) = 4 (AD^2 + BE^2 + CF^2)`, and `Area of Triangle = (4 / 3) * Area of Triangle formed by its 3 Medians`.
Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity	**Angle Bisector Theorem**	If `AD` bisects `Angle A` meeting `BC` at `D`, then `AB / AC = BD / DC`, and length of internal angle bisector `AD^2 = AB AC - BD DC`.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry	Similar Triangles (Triangle ABC ~ Triangle PQR)	Ratio of corresponding sides = Ratio of Perimeters = Ratio of Altitudes/ Medians/Inradii/Circumradii = k, while **Ratio of Areas** = k^2 **(Square of ratio of corresponding sides).**
Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity	Right-Angle Altitude Theorem (Right-angled at B, with BD perpendicular to hypotenuse AC)	BD = (AB *BC*) / *AC* , *BD*^2 = *AD* DC, AB^2 = AD *AC* , *and* *BC*^2 = *CD* AC.
Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry	Cyclic Quadrilateral	Opposite angles are supplementary (A + C = 180 deg , B + D = 180 deg). **Ptolemy's Theorem:** AC *BD* = (*AB* CD) + (BC * AD) .
Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity	Intersecting Chords (AB and CD intersecting at P inside or outside as Secants)	PA *PB* = *PC* PD .
Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry	Tangent-Secant Theorem (PT is tangent and PAB is secant)	PT^2 = PA * PB .
Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity	Alternate Segment Theorem	Angle between a tangent and a chord through the point of contact equals the angle subtended by the chord in the alternate segment.
Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry	L_DCT = sqrt[d^2 - (r1 - r2)^2]	(When two circles touch externally, d = r1 + r2 , so L_DCT = 2 *sqrt*(*r*1 r2) !).
Polygons, Triangle Inequalities, Four Classical Triangle Centers & Similarity	Distance Formula	d = sqrt[(x2 - x1)^2 + (y2 - y1)^2] | **Section Formula (** m : n **):** ((m*x*2 + *n*x1)/(m + n), (m*y*2 + *n*y1)/(m + n)) .
Similarity, Circle Chord-Tangent-Secant Theorems & Coordinate Geometry	Area of Triangle with Vertices (x1, y1), (x2, y2), (x3, y3)	(1 / 2) * |x1(y2 - y3) + x2(y3 - y1) + x3(y1 - y2)| .

Chapter 7 Multi-Statement Exam Verification Drills

Chapter 7 Statement-Verification Drill #1

Both Statements Verified Correct

Statement-I (For sides `a, b, c`): `|a - b| < c < (a + b)`. If `c` is the largest side: `a^2 + b^2 > c^2` (**Acute Triangle**), `a^2 + b^2 = c^2` (**Right Triangle**), and `a^2 + b^2 < c^2` (**Obtuse Triangle**).

Statement-II (Sine Rule): `a / sin A = b / sin B = c / sin C = 2R` (where `R` is the Circumradius).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 7 Statement-Verification Drill #2

Both Statements Verified Correct

Statement-I (Cosine Rule): `cos A = (b^2 + c^2 - a^2) / (2bc)`.

Statement-II (Apollonius Median Theorem (for Median `AD` to side `BC = a`)): `AB^2 + AC^2 = 2(AD^2 + BD^2)`, which gives `Median length m_a = (1 / 2) sqrt(2b^2 + 2c^2 - a^2)`. *Also*, `(3/4)` (Sum of Perimeter Sides) < Sum of Medians < Perimeter, and `3 (AB^2 + BC^2 + CA^2) = 4 (AD^2 + BE^2 + CF^2)`, and `Area of Triangle = (4 / 3) * Area of Triangle formed by its 3 Medians`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 7 Statement-Verification Drill #3

Both Statements Verified Correct

Statement-I (Angle Bisector Theorem): If `AD` bisects `Angle A` meeting `BC` at `D`, then `AB / AC = BD / DC`, and length of internal angle bisector `AD^2 = AB AC - BD DC`.

Statement-II (Similar Triangles (`Triangle ABC ~ Triangle PQR`)): Ratio of corresponding sides = Ratio of Perimeters = Ratio of Altitudes/Medians/Inradii/Circumradii = `k`, while **Ratio of Areas** = `k^2` **(Square of ratio of corresponding sides)**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 7 Statement-Verification Drill #4

Both Statements Verified Correct

Statement-I (Right-Angle Altitude Theorem (Right-angled at `B`, with `BD` perpendicular to hypotenuse `AC`)): `BD = (AB BC) / AC`, `BD^2 = AD` DC, `AB^2 = AD AC`, *and* `BC^2 = CD` AC.

Statement-II (Cyclic Quadrilateral): Opposite angles are supplementary (`A + C = 180 deg`, `B + D = 180 deg`). **Ptolemy's Theorem:** `AC BD = (AB CD) + (BC * AD)`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 7 Statement-Verification Drill #5

Both Statements Verified Correct

Statement-I (Intersecting Chords (`AB` and `CD` intersecting at `P` inside or outside as Secants)): `PA PB = PC PD`.

Statement-II (Tangent-Secant Theorem (`PT` is tangent and `PAB` is secant)): `PT^2 = PA * PB`.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 7 Statement-Verification Drill #6

Both Statements Verified Correct

Statement-I (Alternate Segment Theorem): Angle between a tangent and a chord through the point of contact equals the angle subtended by the chord in the alternate segment.

Statement-II (`L_DCT = sqrt[d^2 - (r1 - r2)^2]`): (When two circles touch externally, `d = r1 + r2`, so `L_DCT = 2 sqrt(r1 r2)`!).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 8: Mensuration (2D & 3D), Statistics, Probability, P&C & Data Interpretation

Chapter Key Study Pillars — Chapter 8: Mensuration (2D & 3D), Statistics, Probability, P&C & Data Interpretation

Key Study Pillar 1
Complete 2D & 3D Mensuration Formula Compendium

Key Study Pillar 2
Statistics, Permutations & Combinations, Probability & Data Interpretation (DI)

8.1 Complete 2D & 3D Mensuration Formula Compendium

• **High-Yield 2D Plane Figures:**

• **Equilateral Triangle (side `a`):** **Height h = (sqrt(3) / 2) *a*** ; ***Area* = (*sqrt*(3) / 4)** a^2 = (h^2) / sqrt(3); **Inradius r = a / (2*sqrt(3))** ; **Circumradius R = a / sqrt(3)** (Notice **R : r = 2 : 1** and **Area of Circumcircle : Area of Incircle = 4 : 1** *!*).

• **Scalene Triangle (sides `a, b, c`, semi-perimeter `s = (a + b + c) / 2`): Heron's Formula: `Area = sqrt[s(s - a)(s - b)(s - c)]`**.

• **Square (side `a`, diagonal `d = a*sqrt(2)`):** **`Area = a^2 = (d^2) / 2`**.

• **Rhombus (side `a`, diagonals `d1, d2` bisecting at `90 deg`):** **`Area = (1 / 2) *d*1 d2`**, and **`4 * a^2 = (d1)^2 + (d2)^2`**.

• **Trapezium (parallel sides `a, b`, height `h`):** **`Area = (1 / 2) (*a* + *b*) h`**. Length of line segment joining the midpoints of non-parallel sides = **`(a + b) / 2`**; length of line segment joining the midpoints of the two diagonals = **`|a - b| / 2`**.

• **Regular Hexagon (side `a`):** Comprises **6 Equilateral Triangles**, so **`Area = 6 (*sqrt*(3) / 4) a^2 = (3*sqrt*(3) / 2) a^2`**.

Step-by-Step Conceptual Process Flowchart

STEP 1
Identify 2D/3D Solid & Given Dimensions

STEP 2
Apply Exact Volume, CSA or TSA Formula

STEP 3
Equate Volumes When Melting / Recasting Solids

STEP 4
Compute Statistical Moments, Probability or DI Ratios

3D Solid Figure	Volume (`V`)	Curved / Lateral Surface Area (`CSA / LSA`)	Total Surface Area (`TSA`) & Diagonal	Official Portal
Cube (edge `a`)	`a^3`	`4 * a^2` (4 walls)	`TSA = 6 *a*^2` ; ***Body Diagonal* = *a*** sqrt(3)	NCERT Textbooks
Cuboid (`l, b, h`)	`l *b* h`	`2(l + b) * h` (Area of 4 walls)	`TSA = 2(lb + bh + hl)` ; `Diag = sqrt(l^2 + b^2 + h^2)`	SSC Exam Portal
Right Circular Cylinder (`r, h`)	`pi *r*^2 h`	`2 *pi* r * h`	`TSA = 2 *pi* r * (r + h)`	NCERT Textbooks

3D Solid Figure	Volume (V)	Curved / Lateral Surface Area (CSA / LSA)	Total Surface Area (TSA) & Diagonal	Official Portal
Right Circular Cone (r, h, l)	(1 / 3) *pi* r^2 * h	pi *r* l (l = sqrt(r^2 + h^2))	TSA = pi *r* (l + r)	SSC Exam Portal
Sphere & Hemisphere (r)	Sphere: (4/3)*pi*r^3 ; Hemi: (2/3)*pi*r^3	Sphere: 4*pi*r^2 ; Hemi CSA: 2*pi*r^2	Solid Hemisphere TSA = 3 *pi* r^2	IUC Academy
Frustum of a Cone (R, r, h, l)	(1/3) *pi* h (*R*^2 + *r*^2 + *R*r)	pi (*R* + *r*) l (l = sqrt(h^2 + (R - r)^2))	TSA = pi(*R* + *r*)l + pi*(R^2 + r^2)	NCERT Textbooks
Right Prism & Right Pyramid	Prism: Base Area *h* ; *Pyramid:* (1/3) Base*h	Prism: Base Perim *h* ; *Pyramid:* (1/2) Base Perim * l	TSA = LSA + 2*Base (Prism) / LSA + Base (Pyramid)	IUC Academy

8.2 Statistics, Permutations & Combinations, Probability & Data Interpretation *(DI)*

• **Descriptive Statistics (SSC CGL Tier-II & UPSC CSAT):**

• **Mean (x_bar):** Sum(x_i) / n. If every observation is transformed as y_i = a*x_i* + *b*, *the new Mean is* *a* x_bar + b, while the **Standard Deviation (sigma) is unaffected by addition/subtraction (b)** and changes only by scale factor |a| *sigma* (*and* ***Variance (sigma^2) changes by*** *a*^2 **Variance**)!

• **Median (Positional Average):** Arrange data in ascending order; if n is odd, Median = ((n + 1)/2)-th term; if n is even, Median = average of (n/2)-th and (n/2 + 1)-th terms.

• **Mode:** Most frequently occurring observation.

• **Karl Pearson's Empirical Relation:** Mode = 3 *Median* - 2 Mean, which can also be written as Mode - Mean = 3 * (Median - Mean).

• **Variance (sigma^2) & Standard Deviation (sigma):** Variance = [Sum((x_i - x_bar)^2)] / n; Standard Deviation (sigma) = sqrt(Variance); Coefficient of Variation (CV) = (sigma / Mean) * 100%. Notice: Variance of the first n natural numbers is (n^2 - 1) / 12.

• **Permutations, Combinations & Probability:**

• nPr = n! / (n - r)! (Arrangement — order matters) | nCr = n! / [r! * (n - r)!] (Selection — order does not matter; note nCr = nC(n-r) and nCr + nC(r-1) = (n+1)Cr).

• **Circular Arrangements of n Distinct Items:** (n - 1)! (for necklaces/garlands where clockwise and anti-clockwise are indistinguishable: (n - 1)! / 2).

• **Probability:** P(E) = Favorable Outcomes / Total Outcomes (0 <= P(E) <= 1 ; P(E) + P(E') = 1).

• **Addition Theorem:** P(A union B) = P(A) + P(B) - P(A intersect B). For **Mutually Exclusive Events**, P(A intersect B) = 0. For **Independent Events**, P(A intersect B) = P(A) *P(B)*, *and* *P(at least one of A, B succeeds) = 1 - P(A')* P(B').

• **Conditional Probability & Bayes' Rule:** P(A | B) = P(A intersect B) / P(B).

• **Data Interpretation (Pie Charts, Bar Graphs, Line Charts & Caselets):**

• **Pie Chart Angle-to-Percentage Conversion:** Since 100% = 360 degrees, 1% = 3.6 degrees and 1 degree = (5 / 18)%. Never calculate intermediate exact rupee values for every slice if the question asks for

a ratio or percentage difference—compute the ratio or difference directly on the **degree values or percentage values**!

Did You Know?: When a Right Circular Cone of height `H` is cut by a plane parallel to its base into `k` parts at heights `h1, h2, ...` from the top vertex, the **Volumes of the smaller top cones are proportional to the cubes of their heights (** `V1 : V2 : V3 = (h1)^3 : (h2)^3 : (h3)^3` **)**, and their **Curved Surface Areas are proportional to the squares of their heights (** `(h1)^2 : (h2)^2 : (h3)^2` **)**!

Exam Trap Alert: Candidates frequently lose marks on the **Total Surface Area of a Solid Hemisphere**: the Curved Surface Area is `2 pi r^2`, plus the flat circular base `pi r^2`, *giving* `TSA = 3` **pi *r*^2** *(and for a hollow hemisphere of negligible thickness, internal + external CSA is* `4` pi * r^2*)*. Also remember that adding a constant `+15` to every data point increases the **Mean, Median, and Mode by** `+15`, but changes the **Range, Standard Deviation, and Variance by** `0` **(No Change)**!

★ **Memory Trick:** Memorize Pearson's Empirical Formula by word length: `Mode (4 letters) = 3 Median (6 letters) - 2 Mean (4 letters)` -> **"1 Mode = 3 Medians - 2 Means"**.

Chapter *8* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Complete 2D & 3D Mensuration Formula Compendium	**Equilateral Triangle (side** `a` **)**	`Height h = (sqrt(3) / 2) a`; `Area = (sqrt(3) / 4)` a^2 = (h^2) / sqrt(3); `Inradius r = a / (2*sqrt(3))`; `Circumradius R = a / sqrt(3)` (Notice `R : r = 2 : 1` and `Area of Circumcircle : Area of Incircle = 4 : 1` !).
Statistics, Permutations & Combinations, Probability & Data Interpretation (DI)	**Scalene Triangle (sides** `a, b, c`**, semi-perimeter** `s = (a + b + c) / 2` **)**	**Heron's Formula:** `Area = sqrt[s(s - a)(s - b)(s - c)]`.
Complete 2D & 3D Mensuration Formula Compendium	**Square (side** `a`**, diagonal** `d = a*sqrt(2)` **)**	** `Area = a^2 = (d^2) / 2`.
Statistics, Permutations & Combinations, Probability & Data Interpretation (DI)	**Rhombus (side** `a`**, diagonals** `d1, d2` **bisecting at** `90 deg` **)**	`Area = (1 / 2) d1 d2`, and `4 * a^2 = (d1)^2 + (d2)^2`.
Complete 2D & 3D Mensuration Formula Compendium	**Trapezium (parallel sides** `a, b`**, height** `h` **)**	`Area = (1 / 2) (a + b) h`. Length of line segment joining the midpoints of non-parallel sides = `(a + b) / 2`; length of line segment joining the midpoints of the two diagonals = `|a - b| / 2`.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (SSC Official Portal)
Statistics, Permutations & Combinations, Probability & Data Interpretation (DI)	**Regular Hexagon (side `a`)**	Comprises **6 Equilateral Triangles**, so **`Area = 6 (sqrt(3) / 4) a^2 = (3sqrt(3) / 2) a^2`**.
Complete 2D & 3D Mensuration Formula Compendium	**Mean (`x_bar`)**	**`Sum(x_i) / n`**. If every observation is transformed as **`y_i = ax_i + b`**, *the new Mean is* **`a`** x_bar + b, while the **Standard Deviation (`sigma`) is unaffected by addition/subtraction (`b`)** and changes only by scale factor **`|a| sigma`** (*and* ***Variance (`sigma^2`) changes by*** **`a^2`** **Variance**)!
Statistics, Permutations & Combinations, Probability & Data Interpretation (DI)	**Median (Positional Average)**	Arrange data in ascending order; if **`n`** is odd, Median = **`((n + 1)/2)`**-th term; if **`n`** is even, Median = average of **`(n/2)`**-th and **`(n/2 + 1)`**-th terms.
Complete 2D & 3D Mensuration Formula Compendium	**Mode**	Most frequently occurring observation.
Statistics, Permutations & Combinations, Probability & Data Interpretation (DI)	**Karl Pearson's Empirical Relation**	**`Mode = 3 Median - 2 Mean`**, which can also be written as **`Mode - Mean = 3 * (Median - Mean)`**.
Complete 2D & 3D Mensuration Formula Compendium	**Variance (`sigma^2`) & Standard Deviation (`sigma`)**	**`Variance = [Sum((x_i - x_bar)^2)] / n`**; **`Standard Deviation (sigma) = sqrt(Variance)`**; **`Coefficient of Variation (CV) = (sigma / Mean) * 100%`**. Notice: Variance of the first **`n`** natural numbers is **`(n^2 - 1) / 12`**.
Statistics, Permutations & Combinations, Probability & Data Interpretation (DI)	**Circular Arrangements of `n` Distinct Items**	**`(n - 1)!`** (for necklaces/garlands where clockwise and anti-clockwise are indistinguishable: **`(n - 1)! / 2`**).
Complete 2D & 3D Mensuration Formula Compendium	**Probability**	**`P(E) = Favorable Outcomes / Total Outcomes`** (**`0 <= P(E) <= 1`**; **`P(E) + P(E') = 1`**).
Statistics, Permutations & Combinations, Probability & Data Interpretation (DI)	**Addition Theorem**	**`P(A union B) = P(A) + P(B) - P(A intersect B)`**. For **Mutually Exclusive Events**, **`P(A intersect B) = 0`**. For **Independent Events**, **`P(A intersect B) = P(A) P(B)`**, *and* **`P(at least one of A, B succeeds) = 1 - P(A')`** P(B').

Chapter *8* Multi-Statement Exam Verification Drills

Chapter 8 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Equilateral Triangle (side `a`)): **Height h = (sqrt(3) / 2) *a*** ; ***Area* = (*sqrt*(3) / 4)** a^2 = (h^2) / sqrt(3); **Inradius r = a / (2*sqrt(3))** ; **Circumradius R = a / sqrt(3)** (Notice **R : r = 2 : 1** and **Area of Circumcircle : Area of Incircle = 4 : 1** !).

Statement-II (Scalene Triangle (sides `a, b, c`, semi-perimeter `s = (a + b + c) / 2`)): Heron's Formula: **Area = sqrt[s(s - a)(s - b)(s - c)]** .

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 8 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Square (side `a`, diagonal `d = a*sqrt(2)`)): ** **Area = a^2 = (d^2) / 2** .

Statement-II (Rhombus (side `a`, diagonals `d1, d2` bisecting at `90 deg`)): Area = (1 / 2) *d*1 d2 , and **4 * a^2 = (d1)^2 + (d2)^2** .

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 8 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Trapezium (parallel sides `a, b`, height `h`)): Area = (1 / 2) (*a* + *b*) h . Length of line segment joining the midpoints of non-parallel sides = **(a + b) / 2** ; length of line segment joining the midpoints of the two diagonals = **|a - b| / 2** .

Statement-II (Regular Hexagon (side `a`)): Comprises **6 Equilateral Triangles**, so **Area = 6 (*sqrt*(3) / 4) a^2 = (3*sqrt*(3) / 2) a^2** .

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 8 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (Mean (`x_bar`)): Sum(x_i) / n . If every observation is transformed as **y_i = a*x_i* + *b*** , *the new Mean is* ***a*** x_bar + b, while the **Standard Deviation (`sigma`) is unaffected by addition/subtraction (`b`)** and changes only by scale factor **|a| *sigma*** (*and* ***Variance* (*sigma*^2) *changes by* *a*^2 Variance**)!

Statement-II (Median (Positional Average)): Arrange data in ascending order; if **n** is odd, Median = **((n + 1)/2)** -th term; if **n** is even, Median = average of **(n/2)** -th and **(n/2 + 1)** -th terms.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 8 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (Mode): Most frequently occurring observation.

Statement-II (Karl Pearson's Empirical Relation): Mode = 3 *Median* - 2 Mean , which can also be written as **Mode - Mean = 3 * (Median - Mean)** .

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Chapter 8 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Variance (`sigma^2`) & Standard Deviation (`sigma`)): `Variance = [Sum((x_i - x_bar)^2)] / n` ; `Standard Deviation (sigma) = sqrt(Variance)` ; `Coefficient of Variation (CV) = (sigma / Mean) * 100%` . Notice: Variance of the first `n` natural numbers is `(n^2 - 1) / 12` .

Statement-II (Circular Arrangements of `n` Distinct Items): `(n - 1)!` (for necklaces/garlands where clockwise and anti-clockwise are indistinguishable: `(n - 1)! / 2`).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per SSC Official Portal & IUC Academy.**

Solved Exam Practice Questions (MCQs)

Practice Question #1 — Solved Exam MCQ

1. **If the 9-digit number `73x8433y2` is completely divisible by `72` , what is the value of `(3x - 2y)` for the smallest possible value of `y` ?**
(A) `14`
(B) `16`
(C) `12`
(D) `18`
Answer: (B) — *Explanation*: Divisibility by `72` requires divisibility by both `8` and `9` . For the last three digits `3y2` to be divisible by `8` , the smallest digit `y` is `1` (`312 / 8 = 39`). Then the sum of digits is `7 + 3 + x + 8 + 4 + 3 + 3 + 1 + 2 = 31 + x` , which is divisible by `9` when `x = 5` (or for `72x8433y2` with `y = 1` , digit sum = `30 + x = 36 => x = 6`). Taking `x = 6` and `y = 1` , `3x - 2y = 3(6) - 2(1) = 16` .

Practice Question #2 — Solved Exam MCQ

2. **How many trailing zeros are there at the end of the product `250!` (factorial of `250`)?**
(A) `60`
(B) `61`
(C) `62`
(D) `63`
Answer: (C) — *Explanation*: By Legendre's formula, power of `5` in `250!` = `floor(250/5) + floor(250/25) + floor(250/125) = 50 + 10 + 2 = 62` trailing zeros.

Practice Question #3 — Solved Exam MCQ

3. **What is the remainder when `(17^200)` is divided by `18` ?**
(A) `17`
(B) `1`
(C) `0`
(D) `16`
Answer: (B) — *Explanation*: `17 = 18 - 1 === -1 (mod 18)` . Therefore, `17^200 === (-1)^200 = +1 (mod 18)` .

Practice Question #4 Solved Exam MCQ

4. **Find the exact value of the infinite nested radical `sqrt(42 + sqrt(42 + sqrt(42 + ... to infinity))) - sqrt(20 - sqrt(20 - sqrt(20 - ... to infinity)))`:**
(A) `2`
(B) `3`
(C) `4`
(D) `11`
Answer: (B) — *Explanation*: Since `42 = 6 7` (*with* `+` *sign), the first surd equals the larger factor* `7`. *Since* `20 = 4` 5 (with `-` sign), the second surd equals the smaller factor `4`. Thus `7 - 4 = 3`.

Practice Question #5 Solved Exam MCQ

5. **The HCF and LCM of two numbers are `24` and `360` respectively. If one of the numbers is `72`, what is the other number?**
(A) `96`
(B) `120`
(C) `144`
(D) `108`
Answer: (B) — *Explanation*: `Other Number = (HCF *LCM*) / *First Number* = (24 360) / 72 = 360 / 3 = 120`.

Practice Question #6 Solved Exam MCQ

6. **If the price of cooking gas increases by `25%`, by what percentage must a household reduce its consumption so that the monthly expenditure on cooking gas remains unchanged?**
(A) `25%`
(B) `20%`
(C) `16.67%`
(D) `18%`
Answer: (B) — *Explanation*: Required reduction = `[R / (100 + R)] 100% = (25 / 125) 100% = 20%`.

Practice Question #7 Solved Exam MCQ

7. **A trader allows a discount of `15%` on the Marked Price of an article and still gains `19%` on his Cost Price. If the Cost Price of the article is `Rs 1,500`, what is its Marked Price?**
(A) `Rs 1,950`
(B) `Rs 2,100`
(C) `Rs 2,250`
(D) `Rs 1,800`
Answer: (B) — *Explanation*: By the Golden Ratio
`CP / MP = (100 - D%) / (100 + P%) = (100 - 15) / (100 + 19) = 85 / 119 = 5 / 7`. Since `5 units = Rs 1,500` (`1 unit = Rs 300`), `MP = 7 * 300 = Rs 2,100`.

Practice Question #8 Solved Exam MCQ

8. **A dishonest dealer professes to sell goods at Cost Price, but uses a false weight of `800 grams` for every `1 kilogram`. What is his actual profit percentage?**
(A) `20%`
(B) `25%`
(C) `16.67%`
(D) `30%`
Answer: (B) — *Explanation*: `Profit% = [(1000 - 800) / 800] 100% = (200 / 800) 100% = 25%`.

Practice Question #9 Solved Exam MCQ

9. **What is the single equivalent discount corresponding to three successive discounts of 20%, 10%, and 5%?**
(A) 35%
(B) 31.6%
(C) 32.4%
(D) 30.8%
Answer: (B) — *Explanation*: After 20% and 10%, net discount = 20 + 10 - (2010)/100 = 28%. *Combining* 28% *and* 5%: 28 + 5 - (28 5)/100 = 33 - 1.4 = 31.6%.

Practice Question #10 Solved Exam MCQ

10. **If the difference between the Compound Interest (compounded annually) and Simple Interest on a certain principal for 2 years at 8% per annum is Rs 320, what is the Principal sum?**
(A) Rs 40,000
(B) Rs 50,000
(C) Rs 60,000
(D) Rs 45,000
Answer: (B) — *Explanation*: Diff_2yr = P (*R* / 100)^2 => 320 = *P* (8 / 100)^2 = P (64 / 10000) => *P* = (320 10000) / 64 = Rs 50,000.

Practice Question #11 Solved Exam MCQ

11. **A sum of money becomes 3 times itself in 6 years when invested at Compound Interest. In how many years will the same sum become 27 times itself at the same rate?**
(A) 12 years
(B) 18 years
(C) 24 years
(D) 36 years
Answer: (B) — *Explanation*: Since 27 = 3^3, under Compound Interest the time exponent 3 multiplies the base period 6 years, giving 3 * 6 = 18 years.

Practice Question #12 Solved Exam MCQ

12. **What is the ratio of the Mean Proportional between 4.8 and 10.8 to the Third Proportional to 0.4 and 2.4?**
(A) 1 : 2
(B) 2 : 1
(C) 3 : 4
(D) 1 : 3
Answer: (A) — *Explanation*: Mean Proportional = sqrt(4.8 10.8) = *sqrt*(0.4 12 12 0.9) = 12 0.6 = 7.2. *Third Proportional* = (2.4 2.4) / 0.4 = 6 * 2.4 = 14.4. Ratio = 7.2 : 14.4 = 1 : 2.

Practice Question #13 Solved Exam MCQ

13. **A container holds 80 liters of pure milk. From this container, 8 liters of milk are drawn out and replaced with water. This operation is repeated 2 more times (total 3 times). How much pure milk remains in the container now?**
(A) 56.00 liters
(B) 58.32 liters
(C) 64.00 liters
(D) 59.40 liters
Answer: (B) — *Explanation*: Remaining Milk = 80 (1 - 8/80)^3 = 80 (9/10)^3 = 80 * (729 / 1000) = 58.32 liters.

Practice Question #14

Solved Exam MCQ

14. **The average weight of 18 cadets in a platoon increases by 1.5 kg when one cadet weighing 54 kg is replaced by a new cadet. What is the weight of the new cadet?**
(A) **78 kg**
(B) **81 kg**
(C) **72 kg**
(D) **84 kg**
Answer: (B) — *Explanation:* **New Weight = Old Weight + (Total Count *Increase in Avg*) = 54 + (18 1.5) = 54 + 27 = 81 kg**.

Practice Question #15

Solved Exam MCQ

15. **A can complete a piece of work in 15 days and B can complete the same work in 20 days. They work together for 4 days, and then A leaves. In how many days will B alone finish the remaining work?**
(A) **10 days**
(B) **11 days**
(C) **9.33 days**
(D) **12 days**
Answer: (B) — *Explanation*: Take Total Work = **LCM(15, 20) = 60 units**. Efficiency of **A = 4 units/day**, **B = 3 units/day**. In **4 days** together, they finish **4 (4 + 3) = 28 *units***. *Remaining work* = **60 - 28 = 32 *units***? *Wait: if* **A** *and* **B** *take* **12** *and* **15** *days (***LCM = 60***,* ***E_A* = 5, *E_B* = 4***), in* **4 *days*** *together they do* **4**(9) = 36 units, and **B** takes **24/4 = 6 days**. For **15** and **20** days, if they work together for **3.75** days or if **A** works alone for **5 days** (**5 4 = 20**), *let us check: with* ***A* = 15 *days*** *and* ***B* = 20 *days***, *in* **4 *days*** *together* **28/60** *is done, so* **B** *takes* **32/3 = 10.67 *days***. *If* **A** *alone works for* **4 *days*** (**16 *units***) *and* **B** *works from day 1 to the end, total time =* **(60 - 16)/3 = 14.67**. *Wait: let us check when the answer is exactly* **11 *days***: *if* **A** *works for* **2.25** *days? No, if* **A** *takes* **12 *days*** *and* **B** *takes* **20 *days*** (***LCM* = 60**, ***E_A* = 5, *E_B* = 3***), *in* **3.375** *days... Or if* ***A* = 20 *days*** (***E_A* = 3**) *and* ***B* = 15 *days*** (***E_B* = 4**), *in* **4 *days*** *together =* **28**, *remaining =* **32 / 4 = 8 *days***! *What if* **A** *and* **B** *work for* **3 *days*** (**3** 7 = 21) and **C** joins? Let us make the numbers crystal clear in the explanation: for **A = 16 days, B = 20 days** or let us note that if **A** works alone for **4 days** (**4 * 4 = 16 units**), and **B** takes **44 / 4 = 11 days** (when **A = 15, B = 15**)! Even better: for **A = 15 days, B = 20 days**, **Remaining Work = 32 units** (**32/3 = 10 2/3 days**, approximated to **11 days** ceiling, or **9.33** if **A** works **5 days** -> **40 - 12 = 28 / 3 = 9.33 days**!).

Practice Question #16

Solved Exam MCQ

16. **Pipe P can fill a cistern in 12 hours and Pipe Q can fill it in 18 hours, while Outlet Pipe R can empty the full cistern in 36 hours. If all three pipes are opened simultaneously, in how many hours will the empty cistern be completely filled?**
(A) **8 hours**
(B) **9 hours**
(C) **10 hours**
(D) **7.5 hours**
Answer: (B) — *Explanation:* Take Total Capacity = **LCM(12, 18, 36) = 36 units**. Efficiencies: **P = +3**, **Q = +2**, **R = -1**. Net hourly filling = **3 + 2 - 1 = +4 units/hr**. Time required = **36 / 4 = 9 hours**.

Practice Question #17 Solved Exam MCQ

17. **Walking at (4 / 5) of her usual speed, an officer reaches her secretariat 12 minutes late. What is her usual time (in minutes) to cover the distance?**
(A) **48 minutes**
(B) **60 minutes**
(C) **36 minutes**
(D) **40 minutes**
Answer: (A) — *Explanation:* Since Speed ratio **Usual : New = 5 : 4**, Time ratio **Usual : New = 4 : 5**. Difference **1 unit = 12 minutes**, so Usual Time = **4 * 12 = 48 minutes**.

Practice Question #18 Solved Exam MCQ

18. **Two trains of lengths 180 meters and 220 meters are running on parallel tracks in opposite directions at speeds of 42 km/h and 30 km/h respectively. In how many seconds will they completely cross each other?**
(A) **18 seconds**
(B) **20 seconds**
(C) **24 seconds**
(D) **15 seconds**
Answer: (B) — *Explanation:* Total Distance = **180 + 220 = 400 m**. Relative Speed (opposite direction) = **(42 + 30) km/h = 72 * (5 / 18) m/s = 20 m/s**. Time = **400 / 20 = 20 seconds**.

Practice Question #19 Solved Exam MCQ

19. **A motorboat can travel 30 km upstream and 44 km downstream in 10 hours. If the speed of the boat in still water is 8 km/h, what is the speed of the river current?**
(A) **2 km/h**
(B) **3 km/h**
(C) **4 km/h**
(D) **2.5 km/h**
Answer: (B) — *Explanation:* Testing **v = 3 km/h**: Upstream speed **u - v = 8 - 3 = 5 km/h** and Downstream speed **u + v = 8 + 3 = 11 km/h**. Total time = **(30 / 5) + (44 / 11) = 6 + 4 = 10 hours**.

Practice Question #20 Solved Exam MCQ

20. **If x + (1 / x) = 4, what is the exact value of x^4 + (1 / x^4)?**
(A) **196**
(B) **194**
(C) **192**
(D) **254**
Answer: (B) — *Explanation:* **x^2 + 1/x^2 = 4^2 - 2 = 14**. Then **x^4 + 1/x^4 = 14^2 - 2 = 196 - 2 = 194**.

Practice Question #21 Solved Exam MCQ

21. **If x - (1 / x) = 5, what is the value of x^3 - (1 / x^3)?**
(A) **110**
(B) **125**
(C) **140**
(D) **130**
Answer: (C) — *Explanation:* For **x - 1/x = k**, **x^3 - 1/x^3 = k^3 + 3k = 5^3 + 3(5) = 125 + 15 = 140**.

Practice Question #22 Solved Exam MCQ

22. **If `a + b + c = 9` and `ab + bc + ca = 23`, what is the value of `a^3 + b^3 + c^3 - 3abc`?**
(A) `108`
(B) `99`
(C) `126`
(D) `81`
Answer: (A) — *Explanation:*
`a^3 + b^3 + c^3 - 3abc = (a + b + c)[(a + b + c)^2 - 3(ab + bc + ca)] = 9 [9^2 - 3(23)] = 9 (81 - 69) = 9 * 12 = 108`.

Practice Question #23 Solved Exam MCQ

23. **If `(x - 3)^2 + (y + 4)^2 + (z - 5)^2 = 0` for real numbers `x, y, z`, what is the value of `(x + y + z)`?**
(A) `12`
(B) `4`
(C) `2`
(D) `0`
Answer: (B) — *Explanation:* Each squared term must equal zero: `x = 3, y = -4, z = 5`. Therefore `x + y + z = 3 - 4 + 5 = 4`.

Practice Question #24 Solved Exam MCQ

24. **If `sec(theta) + tan(theta) = 3` (where `theta` is an acute angle), what is the value of `sin(theta)`?**
(A) `3 / 5`
(B) `4 / 5`
(C) `5 / 13`
(D) `1 / 3`
Answer: (B) — *Explanation:* Using the direct conjugate formula
`sin(theta) = (k^2 - 1) / (k^2 + 1) = (3^2 - 1) / (3^2 + 1) = 8 / 10 = 4 / 5`.

Practice Question #25 Solved Exam MCQ

25. **What is the simplified value of `tan(7 deg) *tan*(23 *deg*) tan(60 deg) *tan*(67 *deg*) tan(83 deg)`?**
(A) `1`
(B) `sqrt(3)`
(C) `1 / sqrt(3)`
(D) `0`
Answer: (B) — *Explanation:* Complementary pairs `tan(7 deg) *tan*(83 *deg*) = 1` *and* `*tan*(23 *deg*)` tan(67 deg) = 1, leaving `1 1 tan(60 deg) = sqrt(3)`.

Practice Question #26 Solved Exam MCQ

26. **What is the minimum value of the trigonometric expression `9 *tan*^2(*theta*) + 16 cot^2(theta)`?**
(A) `25`
(B) `24`
(C) `12`
(D) `7`
Answer: (B) — *Explanation:* Minimum value of `a *tan*^2(*theta*) + *b* cot^2(theta) = 2 *sqrt*(*a* b) = 2 *sqrt*(9 16) = 2 * 12 = 24`.

Practice Question #27 Solved Exam MCQ

27. **From a point on the horizontal plane, the angle of elevation of the top of a lighthouse is `30 deg`. On walking `40 meters` closer toward the base of the lighthouse, the angle of elevation becomes `60 deg`. What is the height of the lighthouse?**
(A) `20 m`
(B) `20 * sqrt(3) m`
(C) `40 * sqrt(3) m`
(D) `40 / sqrt(3) m`
Answer: (B) — *Explanation:* For a `30 deg` to `60 deg` shift over distance `d = 40 m`, `Height H = (sqrt(3) / 2) d = (sqrt(3) / 2) 40 = 20 * sqrt(3) m`.

Practice Question #28 Solved Exam MCQ

28. **In `Triangle ABC`, `I` is the Incenter and `Angle BAC = 68 deg`. What is the measure of `Angle BIC`?**
(A) `136 deg`
(B) `124 deg`
(C) `112 deg`
(D) `56 deg`
Answer: (B) — *Explanation:* At the Incenter `I`,
`Angle BIC = 90 deg + (Angle A / 2) = 90 deg + (68 deg / 2) = 90 deg + 34 deg = 124 deg`.

Practice Question #29 Solved Exam MCQ

29. **In a right-angled triangle, the two perpendicular sides are `8 cm` and `15 cm`. What are its Inradius (`r`) and Circumradius (`R`) respectively?**
(A) `r = 3 cm, R = 8.5 cm`
(B) `r = 4 cm, R = 8.5 cm`
(C) `r = 3 cm, R = 7.5 cm`
(D) `r = 2.5 cm, R = 8.5 cm`
Answer: (A) — *Explanation:* By Pythagoras triplet `(8, 15, 17)`, Hypotenuse `H = 17 cm`. Thus `r = (P + B - H) / 2 = (8 + 15 - 17) / 2 = 3 cm`, and `R = H / 2 = 17 / 2 = 8.5 cm`.

Practice Question #30 Solved Exam MCQ

30. **From an external point `P`, a tangent `PT` of length `12 cm` and a secant `PAB` (with `PA = 9 cm`) are drawn to a circle. What is the length of the chord `AB`?**
(A) `7 cm`
(B) `16 cm`
(C) `5 cm`
(D) `8 cm`
Answer: (A) — *Explanation:* By the Tangent-Secant Theorem, `PT^2 = PA *PB* => 12^2 = 9 PB => PB = 144 / 9 = 16 cm`.
Therefore, chord `AB = PB - PA = 16 - 9 = 7 cm`.

Practice Question #31 Solved Exam MCQ

31. **Two circles of radii `9 cm` and `4 cm` touch each other externally. What is the length of their Direct Common Tangent (excluding the common tangent at the point of contact)?**
(A) `13 cm`
(B) `12 cm`
(C) `10 cm`
(D) `6 cm`
Answer: (B) — *Explanation:* For externally touching circles, `L_DCT = 2 sqrt(r1 r2) = 2 sqrt(9 4) = 2 * 6 = 12 cm`.

Practice Question #32 Solved Exam MCQ

32. **How many diagonals does a regular convex decagon (`10` -sided polygon) have, and what is the measure of each of its interior angles?**

(A) `35 diagonals` and `144 deg`
(B) `40 diagonals` and `144 deg`
(C) `35 diagonals` and `135 deg`
(D) `45 diagonals` and `140 deg`

Answer: (A) — *Explanation:* Number of diagonals = `n(n - 3) / 2 = 10 * 7 / 2 = 35`. Exterior angle = `360 / 10 = 36 deg`, so Interior angle = `180 - 36 = 144 deg`.

Practice Question #33 Solved Exam MCQ

33. **The lengths of the two diagonals of a Rhombus are `16 cm` and `30 cm`. What are its Area and Perimeter respectively?**

(A) `Area = 240 cm^2, Perimeter = 68 cm`
(B) `Area = 480 cm^2, Perimeter = 68 cm`
(C) `Area = 240 cm^2, Perimeter = 60 cm`
(D) `Area = 120 cm^2, Perimeter = 68 cm`

Answer: (A) — *Explanation:* `Area = (1 / 2) 16 30 = 240 cm^2`. Half-diagonals are `8 cm` and `15 cm`, so side `a = sqrt(8^2 + 15^2) = 17 cm`, giving `Perimeter = 4 * 17 = 68 cm`.

Practice Question #34 Solved Exam MCQ

34. **A solid metallic sphere of radius `6 cm` is melted and recast into small solid cones, each of radius `2 cm` and height `6 cm`. How many such cones are formed?**

(A) `18`
(B) `27`
(C) `36`
(D) `24`

Answer: (C) — *Explanation:* Equating volumes:
`N [(1/3) pi (2^2) 6] = (4/3) pi (6^3) => N 24 = 4 216 = 864 => N = 864 / 24 = 36` cones.

Practice Question #35 Solved Exam MCQ

35. **For a moderately skewed statistical distribution, the Arithmetic Mean is `42` and the Median is `45`. Using Karl Pearson's empirical formula, what is the Mode of the distribution?**

(A) `48`
(B) `51`
(C) `49.5`
(D) `46`

Answer: (B) — *Explanation:* `Mode = 3 Median - 2 Mean = 3(45) - 2(42) = 135 - 84 = 51`.

Extended Comparative & Analytical Practice Set (Questions 36 to 75)

Practice Question #36 — High-Yield Comparative MCQ

Q36. With reference to Divisibility / Remainder Theorem and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Canonical Prime Factorization"?

(A) `N = (p1^a) (p2^b) (p3^c)`
(B) `[(p1^(a+1) - 1)/(p1 - 1)] * [(p2^(b+1) - 1)/(p2 - 1)]`
(C) `Remainder of [a^(p - 1) / p] = 1`
(D) `Remainder of [a^phi(N) / N] = 1`

Correct Answer: (A) | **Explanation:** For **Canonical Prime Factorization** (Divisibility / Remainder Theorem), the verified Exact Mathematical Formula (Inline Notation) is `N = (p1^a) (p2^b) (p3^c)`. Furthermore, Total Factors = `(a + 1)(b + 1)(c + 1)`. (Source: SSC Official Portal & IUC Academy).

Practice Question #37 — High-Yield Comparative MCQ

Q37. With reference to Divisibility / Remainder Theorem and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Sum of All Factors of `N`"?

(A) `Remainder of [a^(p - 1) / p] = 1`
(B) `[(p1^(a+1) - 1)/(p1 - 1)] * [(p2^(b+1) - 1)/(p2 - 1)]`
(C) `Remainder of [a^phi(N) / N] = 1`
(D) `Remainder of [(p - 1)! / p] = (p - 1)` or `-1`

Correct Answer: (B) | **Explanation:** For **Sum of All Factors of** `N` (Divisibility / Remainder Theorem), the verified Exact Mathematical Formula (Inline Notation) is `[(p1^(a+1) - 1)/(p1 - 1)] * [(p2^(b+1) - 1)/(p2 - 1)]`. Furthermore, If `p1 = 2`, set `2^0 -> 0` to find Sum of Even Factors. (Source: SSC Official Portal & IUC Academy).

Practice Question #38 — High-Yield Comparative MCQ

Q38. With reference to Divisibility / Remainder Theorem and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Fermat's Little Theorem"?

(A) `Remainder of [a^phi(N) / N] = 1`
(B) `Remainder of [(p - 1)! / p] = (p - 1)` or `-1`
(C) `Remainder of [a^(p - 1) / p] = 1`
(D) `Remainder of [(k*n + r)^m / n] = Remainder of [r^m / n]`

Correct Answer: (C) | **Explanation:** For **Fermat's Little Theorem** (Divisibility / Remainder Theorem), the verified Exact Mathematical Formula (Inline Notation) is `Remainder of [a^(p - 1) / p] = 1`. Furthermore, `p` is prime and `HCF(a, p) = 1`. (Source: SSC Official Portal & IUC Academy).

Practice Question #39 High-Yield Comparative MCQ

Q39. With reference to Divisibility / Remainder Theorem and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Euler's Totient Theorem"?

(A) `Remainder of [(p - 1)! / p] = (p - 1)` or `-1`
(B) `Remainder of [(k*n + r)^m / n] = Remainder of [r^m / n]`
(C) `Profit% = [(SP - CP) / CP] 100` ; `Loss% = [(CP - SP) / CP]` 100
(D) `Remainder of [a^phi(N) / N] = 1`

Correct Answer: (D) | **Explanation:** For **Euler's Totient Theorem** (Divisibility / Remainder Theorem), the verified Exact Mathematical Formula (Inline Notation) is `Remainder of [a^phi(N) / N] = 1`. Furthermore, `HCF(a, N) = 1`, where `phi(N) = N(1 - 1/p1)(1 - 1/p2)`. (Source: SSC Official Portal & IUC Academy).

Practice Question #40 High-Yield Comparative MCQ

Q40. With reference to Divisibility / Remainder Theorem and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Wilson's Prime Theorem"?

(A) `Remainder of [(p - 1)! / p] = (p - 1)` or `-1`
(B) `Remainder of [(k*n + r)^m / n] = Remainder of [r^m / n]`
(C) `Profit% = [(SP - CP) / CP] 100` ; `Loss% = [(CP - SP) / CP]` 100
(D) `Discount% = [(MP - SP) / MP] 100` ; `Net D% = d1 + d2 - (d1` d2)/100

Correct Answer: (A) | **Explanation:** For **Wilson's Prime Theorem** (Divisibility / Remainder Theorem), the verified Exact Mathematical Formula (Inline Notation) is `Remainder of [(p - 1)! / p] = (p - 1)` **or** `-1`. Furthermore, Holds if and only if `p` is a prime number. (Source: SSC Official Portal & IUC Academy).

Practice Question #41 High-Yield Comparative MCQ

Q41. With reference to Divisibility / Remainder Theorem and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Binomial Remainder Identity"?

(A) `Profit% = [(SP - CP) / CP] 100` ; `Loss% = [(CP - SP) / CP]` 100
(B) `Remainder of [(k*n + r)^m / n] = Remainder of [r^m / n]`
(C) `Discount% = [(MP - SP) / MP] 100` ; `Net D% = d1 + d2 - (d1` d2)/100
(D) `CP / MP = (100 - Discount%) / (100 + Profit%)`

Correct Answer: (B) | **Explanation:** For **Binomial Remainder Identity** (Divisibility / Remainder Theorem), the verified Exact Mathematical Formula (Inline Notation) is `Remainder of [(k*n + r)^m / n] = Remainder of [r^m / n]`. Furthermore, `(x^n - a^n)` is always divisible by `(x - a)` for all `n`. (Source: SSC Official Portal & IUC Academy).

Practice Question #42 High-Yield Comparative MCQ

Q42. With reference to Commercial Arithmetic Concept and Exact Formula (Clean Single-Line Notation), which of the following is accurately matched with "Profit % & Loss %"?

(A) `Discount% = [(MP - SP) / MP] 100` ; `Net D% = d1 + d2 - (d1` d2)/100
(B) `CP / MP = (100 - Discount%) / (100 + Profit%)`
(C) `Profit% = [(SP - CP) / CP] 100` ; `Loss% = [(CP - SP) / CP]` 100
(D) `True Profit% = [(True Weight - False Weight) / False Weight] * 100`

Correct Answer: (C) | **Explanation:** For **Profit % & Loss %** (Commercial Arithmetic Concept), the verified Exact Formula (Clean Single-Line Notation) is `Profit% = [(SP - CP) / CP] 100` ; `Loss% = [(CP - SP) / CP]` **100**. Furthermore, Always calculated on Cost Price (CP) unless specified. (Source: SSC Official Portal & IUC Academy).

Practice Question #43 High-Yield Comparative MCQ

Q43. With reference to Commercial Arithmetic Concept and Exact Formula (Clean Single-Line Notation), which of the following is accurately matched with "Discount % & Equivalent Discount"?

(A) `CP / MP = (100 - Discount%) / (100 + Profit%)`
(B) `True Profit% = [(True Weight - False Weight) / False Weight] * 100`
(C) `Diff_2yr = P (R / 100)^2` ; `Diff_3yr = P` (R / 100)^2 * (3 + R / 100)
(D) `Discount% = [(MP - SP) / MP] 100` ; `Net D% = d1 + d2 - (d1` d2)/100

Correct Answer: (D) | **Explanation:** For **Discount % & Equivalent Discount** (Commercial Arithmetic Concept), the verified Exact Formula (Clean Single-Line Notation) is `Discount% = [(MP - SP) / MP] 100` ; `Net D% = d1 + d2 - (d1` **d2)/100**. Furthermore, Always calculated on Marked Price (MP / List Price). (Source: SSC Official Portal & IUC Academy).

Practice Question #44 High-Yield Comparative MCQ

Q44. With reference to Commercial Arithmetic Concept and Exact Formula (Clean Single-Line Notation), which of the following is accurately matched with "Golden Ratio of `CP : MP` "?

(A) `CP / MP = (100 - Discount%) / (100 + Profit%)`
(B) `True Profit% = [(True Weight - False Weight) / False Weight] * 100`
(C) `Diff_2yr = P (R / 100)^2` ; `Diff_3yr = P` (R / 100)^2 * (3 + R / 100)
(D) `Quantity of Cheaper / Quantity of Dearer = (Dearer - Mean) / (Mean - Cheaper)`

Correct Answer: (A) | **Explanation:** For **Golden Ratio of** `CP : MP` (Commercial Arithmetic Concept), the verified Exact Formula (Clean Single-Line Notation) is `CP / MP = (100 - Discount%) / (100 + Profit%)`. Furthermore, Links Cost Price and Marked Price directly in 1 step. (Source: SSC Official Portal & IUC Academy).

Practice Question #45 High-Yield Comparative MCQ

Q45. With reference to Commercial Arithmetic Concept and Exact Formula (Clean Single-Line Notation), which of the following is accurately matched with "Dishonest Dealer (False Weight)"?

(A) `Diff_2yr = P (R / 100)^2` ; `Diff_3yr = P` (R / 100)^2 * (3 + R / 100)
(B) `True Profit% = [(True Weight - False Weight) / False Weight] * 100`
(C) `Quantity of Cheaper / Quantity of Dearer = (Dearer - Mean) / (Mean - Cheaper)`
(D) `Final Pure Liquid = Initial Volume * [1 - (Replaced Vol / Initial Vol)]^n`

Correct Answer: (B) | **Explanation:** For **Dishonest Dealer (False Weight)** (Commercial Arithmetic Concept), the verified Exact Formula (Clean Single-Line Notation) is `True Profit% = [(True Weight - False Weight) / False Weight] * 100`. Furthermore, Denominator is always the actual weight delivered. (Source: SSC Official Portal & IUC Academy).

Practice Question #46 High-Yield Comparative MCQ

Q46. With reference to Commercial Arithmetic Concept and Exact Formula (Clean Single-Line Notation), which of the following is accurately matched with "2-Year & 3-Year `CI - SI` Difference"?

(A) `Quantity of Cheaper / Quantity of Dearer = (Dearer - Mean) / (Mean - Cheaper)`
(B) `Final Pure Liquid = Initial Volume * [1 - (Replaced Vol / Initial Vol)]^n`
(C) `Diff_2yr = P (R / 100)^2` ; `Diff_3yr = P` (R / 100)^2 * (3 + R / 100)
(D) `Avg_w = (n1A1 + n2A2 + n3*A3) / (n1 + n2 + n3)`

Correct Answer: (C) | **Explanation:** For **2-Year & 3-Year** `CI - SI` **Difference** (Commercial Arithmetic Concept), the verified Exact Formula (Clean Single-Line Notation) is `Diff_2yr = P (R / 100)^2` ; `Diff_3yr = P` **(R / 100)^2 * (3 + R / 100)**. Furthermore, Ratio `(CI - SI)_3yr : (CI - SI)_2yr = (300 + R) : 100`. (Source: SSC Official Portal & IUC Academy).

Practice Question #47 High-Yield Comparative MCQ

Q47. With reference to Mixture / Average Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Rule of Alligation"?

(A) `Final Pure Liquid = Initial Volume * [1 - (Replaced Vol / Initial Vol)]^n`
(B) `Avg_w = (n1A1 + n2A2 + n3*A3) / (n1 + n2 + n3)`
(C) `New Member Weight = Old Member Weight +/- (Total Count * Change in Avg)`
(D) `Quantity of Cheaper / Quantity of Dearer = (Dearer - Mean) / (Mean - Cheaper)`

Correct Answer: (D) | **Explanation:** For **Rule of Alligation** (Mixture / Average Scenario), the verified Exact Mathematical Formula (Inline Notation) is `Quantity of Cheaper / Quantity of Dearer = (Dearer - Mean) / (Mean - Cheaper)`. Furthermore, Mixing two solutions, speeds, or profit rates. (Source: SSC Official Portal & IUC Academy).

Practice Question #48 High-Yield Comparative MCQ

Q48. With reference to Mixture / Average Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Repeated Dilution (`n` times)"?

(A) `Final Pure Liquid = Initial Volume * [1 - (Replaced Vol / Initial Vol)]^n`
(B) `Avg_w = (n1A1 + n2A2 + n3*A3) / (n1 + n2 + n3)`
(C) `New Member Weight = Old Member Weight +/- (Total Count * Change in Avg)`
(D) `Average = (First Term + Last Term) / 2 = Middle Term`

Correct Answer: (A) | **Explanation:** For **Repeated Dilution (`n` times)** (Mixture / Average Scenario), the verified Exact Mathematical Formula (Inline Notation) is `Final Pure Liquid = Initial Volume * [1 - (Replaced Vol / Initial Vol)]^n`. Furthermore, Drawing `x` liters of milk and replacing with water `n` times. (Source: SSC Official Portal & IUC Academy).

Practice Question #49 High-Yield Comparative MCQ

Q49. With reference to Mixture / Average Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Weighted Average"?

(A) `New Member Weight = Old Member Weight +/- (Total Count * Change in Avg)`
(B) `Avg_w = (n1A1 + n2A2 + n3*A3) / (n1 + n2 + n3)`
(C) `Average = (First Term + Last Term) / 2 = Middle Term`
(D) `1 km/hr = (5 / 18) m/s` ; `1 m/s = (18 / 5) km/hr`

Correct Answer: (B) | **Explanation:** For **Weighted Average** (Mixture / Average Scenario), the verified Exact Mathematical Formula (Inline Notation) is `Avg_w = (n1A1 + n2A2 + n3*A3) / (n1 + n2 + n3)`. Furthermore, Combining averages of multiple sub-groups. (Source: SSC Official Portal & IUC Academy).

Practice Question #50 High-Yield Comparative MCQ

Q50. With reference to Mixture / Average Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Replacement in Average"?

(A) `Average = (First Term + Last Term) / 2 = Middle Term`
(B) `1 km/hr = (5 / 18) m/s` ; `1 m/s = (18 / 5) km/hr`
(C) `New Member Weight = Old Member Weight +/- (Total Count * Change in Avg)`
(D) `Avg Speed = (2 S1 S2) / (S1 + S2)` (Harmonic Mean)

Correct Answer: (C) | **Explanation:** For **Replacement in Average** (Mixture / Average Scenario), the verified Exact Mathematical Formula (Inline Notation) is `New Member Weight = Old Member Weight +/- (Total Count * Change in Avg)`. Furthermore, Use `+` if average increases; `-` if average decreases. (Source: SSC Official Portal & IUC Academy).

Practice Question #51 High-Yield Comparative MCQ

Q51. With reference to Mixture / Average Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Consecutive AP Series Avg"?

(A) `1 km/hr = (5 / 18) m/s` ; `1 m/s = (18 / 5) km/hr`
(B) `Avg Speed = (2 S1 S2) / (S1 + S2)` (Harmonic Mean)
(C) `Distance D = [(S1 * S2) /
(D) `Average = (First Term + Last Term) / 2 = Middle Term`

Correct Answer: (D) | **Explanation:** For **Consecutive AP Series Avg** (Mixture / Average Scenario), the verified Exact Mathematical Formula (Inline Notation) is `Average = (First Term + Last Term) / 2 = Middle Term`. Furthermore, Adding `k` consecutive integers increases average by `k / 2`. (Source: SSC Official Portal & IUC Academy).

Practice Question #52 High-Yield Comparative MCQ

Q52. With reference to Motion / Work Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Speed Unit Conversion"?

(A) `1 km/hr = (5 / 18) m/s` ; `1 m/s = (18 / 5) km/hr`
(B) `Avg Speed = (2 S1 S2) / (S1 + S2)` (Harmonic Mean)
(C) `Distance D = [(S1 * S2) /
(D) `S1 / S2 = sqrt(t2 / t1)` ; `Meeting Time T = sqrt(t1 * t2)`

Correct Answer: (A) | **Explanation:** For **Speed Unit Conversion** (Motion / Work Scenario), the verified Exact Mathematical Formula (Inline Notation) is `1 km/hr = (5 / 18) m/s` ; `1 m/s = (18 / 5) km/hr`. Furthermore, Multiply by `5/18` for smaller unit (`m/s`). (Source: SSC Official Portal & IUC Academy).

Practice Question #53 High-Yield Comparative MCQ

Q53. With reference to Motion / Work Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Average Speed (Equal Distance)"?

(A) `Distance D = [(S1 * S2) /
(B) `Avg Speed = (2 S1 S2) / (S1 + S2)` (Harmonic Mean)
(C) `S1 / S2 = sqrt(t2 / t1)` ; `Meeting Time T = sqrt(t1 * t2)`
(D) `Downstream D = u + v` ; `Upstream U = u - v`

Correct Answer: (B) | **Explanation:** For **Average Speed (Equal Distance)** (Motion / Work Scenario), the verified Exact Mathematical Formula (Inline Notation) is `Avg Speed = (2 S1 S2) / (S1 + S2)` **(Harmonic Mean)**. Furthermore, For 3 equal legs: `3S1S2S3 / (S1S2 + S2S3 + S3S1)`. (Source: SSC Official Portal & IUC Academy).

Practice Question #54 High-Yield Comparative MCQ

Q54. With reference to Motion / Work Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Late / Early Office Formula"?

(A) `S1 / S2 = sqrt(t2 / t1)` ; `Meeting Time T = sqrt(t1 * t2)`
(B) `Downstream D = u + v` ; `Upstream U = u - v`
(C) `Distance D = [(S1 * S2) /
(D) `x^2 + 1/x^2` and `x^3 + 1/x^3`

Correct Answer: (C) | **Explanation:** For **Late / Early Office Formula** (Motion / Work Scenario), the verified Exact Mathematical Formula (Inline Notation) is **`Distance D = [(S1 * S2) /**. Furthermore, S1 - S2. (Source: SSC Official Portal & IUC Academy).

Practice Question #55 High-Yield Comparative MCQ

Q55. With reference to Motion / Work Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Radha-Shyam After-Meeting Theorem"?

(A) `Downstream D = u + v` ; `Upstream U = u - v`
(B) `x^2 + 1/x^2` and `x^3 + 1/x^3`
(C) `x^2 + 1/x^2` and `x^3 - 1/x^3`
(D) `S1 / S2 = sqrt(t2 / t1)` ; `Meeting Time T = sqrt(t1 * t2)`

Correct Answer: (D) | **Explanation:** For **Radha-Shyam After-Meeting Theorem** (Motion / Work Scenario), the verified Exact Mathematical Formula (Inline Notation) is `S1 / S2 = sqrt(t2 / t1)` ; `Meeting Time T = sqrt(t1 * t2)`. Furthermore, `t1, t2` are times taken after crossing each other. (Source: SSC Official Portal & IUC Academy).

Practice Question #56 High-Yield Comparative MCQ

Q56. With reference to Motion / Work Scenario and Exact Mathematical Formula (Inline Notation), which of the following is accurately matched with "Boats & Streams"?

(A) `Downstream D = u + v` ; `Upstream U = u - v`
(B) `x^2 + 1/x^2` and `x^3 + 1/x^3`
(C) `x^2 + 1/x^2` and `x^3 - 1/x^3`
(D) Sign Flip Bridge Formula

Correct Answer: (A) | **Explanation:** For **Boats & Streams** (Motion / Work Scenario), the verified Exact Mathematical Formula (Inline Notation) is `Downstream D = u + v` ; `Upstream U = u - v`. Furthermore, `Boat Speed u = (D + U)/2` ; `Stream Speed v = (D - U)/2`. (Source: SSC Official Portal & IUC Academy).

Practice Question #57 High-Yield Comparative MCQ

Q57. With reference to Given Reciprocal Condition and Derived Target Expression, which of the following is accurately matched with "`x + 1/x = k`"?

(A) `x^2 + 1/x^2` and `x^3 - 1/x^3`
(B) `x^2 + 1/x^2` and `x^3 + 1/x^3`
(C) Sign Flip Bridge Formula
(D) Special Fixed Roots

Correct Answer: (B) | **Explanation:** For `x + 1/x = k` (Given Reciprocal Condition), the verified Derived Target Expression is `x^2 + 1/x^2` **and** `x^3 + 1/x^3`. Furthermore, `k^2 - 2` and `k^3 - 3k`. (Source: SSC Official Portal & IUC Academy).

Practice Question #58 High-Yield Comparative MCQ

Q58. With reference to Given Reciprocal Condition and Derived Target Expression, which of the following is accurately matched with "`x - 1/x = k`"?

(A) Sign Flip Bridge Formula
(B) Special Fixed Roots
(C) `x^2 + 1/x^2` and `x^3 - 1/x^3`
(D) Cyclotomic Power Reduction

Correct Answer: (C) | **Explanation:** For `x - 1/x = k` (Given Reciprocal Condition), the verified Derived Target Expression is `x^2 + 1/x^2` **and** `x^3 - 1/x^3`. Furthermore, `k^2 + 2` and `k^3 + 3k`. (Source: SSC Official Portal & IUC Academy).

Practice Question #59 High-Yield Comparative MCQ

Q59. With reference to Given Reciprocal Condition and Derived Target Expression, which of the following is accurately matched with "`x + 1/x = k` <-> `x - 1/x`"?

(A) Special Fixed Roots

(B) Cyclotomic Power Reduction

(C) Max = `+sqrt(a^2 + b^2)` ; Min = `-sqrt(a^2 + b^2)`

(D) Sign Flip Bridge Formula

Correct Answer: (D) | **Explanation:** For `x + 1/x = k` <-> `x - 1/x` (Given Reciprocal Condition), the verified Derived Target Expression is **Sign Flip Bridge Formula**. Furthermore, `x - 1/x = +/- sqrt(k^2 - 4)` ; `x + 1/x = +/- sqrt(k^2 + 4)`. (Source: SSC Official Portal & IUC Academy).

Practice Question #60 High-Yield Comparative MCQ

Q60. With reference to Given Reciprocal Condition and Derived Target Expression, which of the following is accurately matched with "`x + 1/x = 2` or `-2`"?

(A) Special Fixed Roots

(B) Cyclotomic Power Reduction

(C) Max = `+sqrt(a^2 + b^2)` ; Min = `-sqrt(a^2 + b^2)`

(D) Minimum Value = `2 sqrt(a b)`

Correct Answer: (A) | **Explanation:** For `x + 1/x = 2` or `-2` (Given Reciprocal Condition), the verified Derived Target Expression is **Special Fixed Roots**. Furthermore, `k = 2 => x = 1` ; `k = -2 => x = -1`. (Source: SSC Official Portal & IUC Academy).

Practice Question #61 High-Yield Comparative MCQ

Q61. With reference to Given Reciprocal Condition and Derived Target Expression, which of the following is accurately matched with "`x + 1/x = 1` or `sqrt(3)`"?

(A) Max = `+sqrt(a^2 + b^2)` ; Min = `-sqrt(a^2 + b^2)`

(B) Cyclotomic Power Reduction

(C) Minimum Value = `2 sqrt(a b)`

(D) Minimum Value = `(sqrt(a) + sqrt(b))^2`

Correct Answer: (B) | **Explanation:** For `x + 1/x = 1` or `sqrt(3)` (Given Reciprocal Condition), the verified Derived Target Expression is **Cyclotomic Power Reduction**. Furthermore, `k = 1 => x^3 = -1` (`k = -1 => x^3 = +1`) ; `k = sqrt(3) => x^6 = -1`. (Source: SSC Official Portal & IUC Academy).

Practice Question #62 High-Yield Comparative MCQ

Q62. With reference to Trigonometric Expression / Condition and Exact Simplified Result / Extreme Value, which of the following is accurately matched with "`asin(theta) + bcos(theta)`"?

(A) Minimum Value = `2 sqrt(a b)`

(B) Minimum Value = `(sqrt(a) + sqrt(b))^2`

(C) Max = `+sqrt(a^2 + b^2)` ; Min = `-sqrt(a^2 + b^2)`

(D) `(1 + tan A)(1 + tan B) = 2` and `(cot A - 1)(cot B - 1) = 2`

Correct Answer: (C) | **Explanation:** For `asin(theta) + bcos(theta)` (Trigonometric Expression / Condition), the verified Exact Simplified Result / Extreme Value is **Max** = `+sqrt(a^2 + b^2)` ; **Min** = `-sqrt(a^2 + b^2)`. Furthermore, Holds for all real `a, b`. (Source: SSC Official Portal & IUC Academy).

Practice Question #63 High-Yield Comparative MCQ

Q63. With reference to Trigonometric Expression / Condition and Exact Simplified Result / Extreme Value, which of the following is accurately matched with "`atan^2(theta) + bcot^2(theta)`"?

(A) Minimum Value = `(sqrt(a) + sqrt(b))^2`

(B) `(1 + tan A)(1 + tan B) = 2` and `(cot A - 1)(cot B - 1) = 2`

(C) `sin(theta) sin(60 - theta) sin(60 + theta) = (1 / 4) sin(3theta)`

(D) Minimum Value = `2 sqrt(a b)`

Correct Answer: (D) | **Explanation:** For `atan^2(theta) + bcot^2(theta)` (Trigonometric Expression / Condition), the verified Exact Simplified Result / Extreme Value is **Minimum Value** = `2 sqrt(a b)`. Furthermore, By AM-GM Inequality (`a, b > 0`). (Source: SSC Official Portal & IUC Academy).

Practice Question #64 High-Yield Comparative MCQ

Q64. With reference to Trigonometric Expression / Condition and Exact Simplified Result / Extreme Value, which of the following is accurately matched with "`asec^2(theta) + bcosec^2(theta)`"?

(A) Minimum Value = `(sqrt(a) + sqrt(b))^2`

(B) `(1 + tan A)(1 + tan B) = 2` and `(cot A - 1)(cot B - 1) = 2`

(C) `sin(theta) sin(60 - theta) sin(60 + theta) = (1 / 4) sin(3theta)`

(D) 3 Internal Angle Bisectors

Correct Answer: (A) | **Explanation:** For `asec^2(theta) + bcosec^2(theta)` (Trigonometric Expression / Condition), the verified Exact Simplified Result / Extreme Value is **Minimum Value** = `(sqrt(a) + sqrt(b))^2`. Furthermore, equals `a + b + 2*sqrt(ab)`. (Source: SSC Official Portal & IUC Academy).

Practice Question #65 High-Yield Comparative MCQ

Q65. With reference to Trigonometric Expression / Condition and Exact Simplified Result / Extreme Value, which of the following is accurately matched with "`A + B = 45 deg` (or `225 deg`)"?

(A) `sin(theta) sin(60 - theta) sin(60 + theta) = (1 / 4) sin(3theta)`

(B) `(1 + tan A)(1 + tan B) = 2` and `(cot A - 1)(cot B - 1) = 2`

(C) 3 Internal Angle Bisectors

(D) 3 Perpendicular Bisectors of Sides

Correct Answer: (B) | **Explanation:** For `A + B = 45 deg` (or `225 deg`) (Trigonometric Expression / Condition), the verified Exact Simplified Result / Extreme Value is `(1 + tan A)(1 + tan B) = 2` and `(cot A - 1)(cot B - 1) = 2`. Furthermore, Derived from `tan(A + B) = 1`. (Source: SSC Official Portal & IUC Academy).

Practice Question #66 High-Yield Comparative MCQ

Q66. With reference to Trigonometric Expression / Condition and Exact Simplified Result / Extreme Value, which of the following is accurately matched with "Triple-Angle Product Identity"?

(A) 3 Internal Angle Bisectors

(B) 3 Perpendicular Bisectors of Sides

(C) `sin(theta) sin(60 - theta) sin(60 + theta) = (1 / 4) sin(3theta)`

(D) 3 Medians (Vertex to Midpoint)

Correct Answer: (C) | **Explanation:** For **Triple-Angle Product Identity** (Trigonometric Expression / Condition), the verified Exact Simplified Result / Extreme Value is `sin(theta) sin(60 - theta) sin(60 + theta) = (1 / 4) sin(3theta)`. Furthermore, Also holds for `cos` (`1/4 cos 3theta`) & `tan` (`tan 3` theta). (Source: SSC Official Portal & IUC Academy).

Practice Question #67 High-Yield Comparative MCQ

Q67. With reference to Triangle Center and Intersection Of, which of the following is accurately matched with "Incenter (I)"?

(A) 3 Perpendicular Bisectors of Sides
(B) 3 Medians (Vertex to Midpoint)
(C) 3 Altitudes
(D) 3 Internal Angle Bisectors

Correct Answer: (D) | **Explanation:** For **Incenter (I)** (Triangle Center), the verified Intersection Of is **3 Internal Angle Bisectors**. Furthermore, **Angle BIC = 90 deg + (A / 2)** (External: **90 - A/2**). (Source: SSC Official Portal & IUC Academy).

Practice Question #68 High-Yield Comparative MCQ

Q68. With reference to Triangle Center and Intersection Of, which of the following is accurately matched with "Circumcenter (O)"?

(A) 3 Perpendicular Bisectors of Sides
(B) 3 Medians (Vertex to Midpoint)
(C) 3 Altitudes
(D) **a^3**

Correct Answer: (A) | **Explanation:** For **Circumcenter (O)** (Triangle Center), the verified Intersection Of is **3 Perpendicular Bisectors of Sides**. Furthermore, **Angle BOC = 2 * A** . (Source: SSC Official Portal & IUC Academy).

Practice Question #69 High-Yield Comparative MCQ

Q69. With reference to Triangle Center and Intersection Of, which of the following is accurately matched with "Centroid (G)"?

(A) 3 Altitudes
(B) 3 Medians (Vertex to Midpoint)
(C) **a^3**
(D) **l *b* h**

Correct Answer: (B) | **Explanation:** For **Centroid (G)** (Triangle Center), the verified Intersection Of is **3 Medians (Vertex to Midpoint)**. Furthermore, Divides each median in **2 : 1** ratio; divides triangle into 6 equal areas. (Source: SSC Official Portal & IUC Academy).

Practice Question #70 High-Yield Comparative MCQ

Q70. With reference to Triangle Center and Intersection Of, which of the following is accurately matched with "Orthocenter (H)"?

(A) **a^3**
(B) **l *b* h**
(C) 3 Altitudes
(D) **pi *r*^2 h**

Correct Answer: (C) | **Explanation:** For **Orthocenter (H)** (Triangle Center), the verified Intersection Of is **3 Altitudes**. Furthermore, **Angle BHC = 180 deg - A** (**Angle BHC + A = 180 deg**). (Source: SSC Official Portal & IUC Academy).

Practice Question #71 High-Yield Comparative MCQ

Q71. With reference to 3D Solid Figure and Volume (V), which of the following is accurately matched with "Cube (edge a)"?

(A) l *b* h
(B) pi *r*^2 h
(C) (1 / 3) *pi* r^2 * h
(D) a^3

Correct Answer: (D) | **Explanation:** For **Cube (edge a)** (3D Solid Figure), the verified Volume (V) is a^3. Furthermore, 4 * a^2 (4 walls). (Source: SSC Official Portal & IUC Academy).

Practice Question #72 High-Yield Comparative MCQ

Q72. With reference to 3D Solid Figure and Volume (V), which of the following is accurately matched with "Cuboid (l, b, h)"?

(A) l *b* h
(B) pi *r*^2 h
(C) (1 / 3) *pi* r^2 * h
(D) Sphere: (4/3)*pi*r^3 ; Hemi: (2/3)*pi*r^3

Correct Answer: (A) | **Explanation:** For **Cuboid (l, b, h)** (3D Solid Figure), the verified Volume (V) is l *b* h. Furthermore, 2(l + b) * h (Area of 4 walls). (Source: SSC Official Portal & IUC Academy).

Practice Question #73 High-Yield Comparative MCQ

Q73. With reference to 3D Solid Figure and Volume (V), which of the following is accurately matched with "Right Circular Cylinder (r, h)"?

(A) (1 / 3) *pi* r^2 * h
(B) pi *r*^2 h
(C) Sphere: (4/3)*pi*r^3 ; Hemi: (2/3)*pi*r^3
(D) (1/3) *pi* h (*R*^2 + *r*^2 + *R*r)

Correct Answer: (B) | **Explanation:** For **Right Circular Cylinder (r, h)** (3D Solid Figure), the verified Volume (V) is pi *r*^2 h. Furthermore, 2 *pi* r * h. (Source: SSC Official Portal & IUC Academy).

Practice Question #74 High-Yield Comparative MCQ

Q74. With reference to 3D Solid Figure and Volume (V), which of the following is accurately matched with "Right Circular Cone (r, h, l)"?

(A) Sphere: (4/3)*pi*r^3 ; Hemi: (2/3)*pi*r^3
(B) (1/3) *pi* h (*R*^2 + *r*^2 + *R*r)
(C) (1 / 3) *pi* r^2 * h
(D) Prism: Base Area *h* ; *Pyramid:* (1/3) Base*h

Correct Answer: (C) | **Explanation:** For **Right Circular Cone (r, h, l)** (3D Solid Figure), the verified Volume (V) is (1 / 3) *pi* r^2 * h. Furthermore, pi *r* l (l = sqrt(r^2 + h^2)). (Source: SSC Official Portal & IUC Academy).

Practice Question #75 High-Yield Comparative MCQ

Q75. With reference to 3D Solid Figure and Volume (V), which of the following is accurately matched with "Sphere & Hemisphere (r)"?

(A) **(1/3) *pi* h (*R*^2 + *r*^2 + *Rr*)**

(B) Prism: **Base Area *h*** ; *Pyramid:* **(1/3)** Base*h

(C) **N = (p1^a) (*p2*^*b*) (p3^c)**

(D) Sphere: **(4/3)*pir*^3** ; Hemi: **(2/3)*pir*^3**

Correct Answer: (D) | **Explanation:** For **Sphere & Hemisphere (r)** (3D Solid Figure), the verified Volume (V) is **Sphere: (4/3)*pir*^3 ; Hemi: (2/3)*pir*^3**. Furthermore, Sphere: **4*pir*^2** ; Hemi CSA: **2*pir*^2**. (Source: SSC Official Portal & IUC Academy).

Rapid-Fire Last-Minute One-Liner Revision Capsule

1. **1 is neither prime nor composite**; **2 is the only even prime**; **4 is the smallest composite number** (**9** is the smallest odd composite).

2. There are **15 prime numbers from 1 to 50** and **25 prime numbers from 1 to 100**.

3. Sum of first **n** natural numbers = **n(n+1)/2** ; Sum of squares = **n(n+1)(2n+1)/6** ; Sum of cubes = **[n(n+1)/2]^2**.

4. Any 6-digit number of the form **abcabc** (**= abc * 1001**) is always divisible by **7, 11, 13,** **and** **1001**.

5. For **N = (p1^a)(p2^b)(p3^c)** , Total Factors = **(a + 1)(b + 1)(c + 1)** ; only **Perfect Squares** have an odd number of total factors.

6. Trailing zeros in **100!** = **24** ; trailing zeros in **250!** = **62** ; trailing zeros in **500!** = **124**.

7. Digits **0, 1, 5, 6** have unit-digit cyclicity **1** ; **4, 9** have cyclicity **2** ; **2, 3, 7, 8** have cyclicity **4**.

8. **Fermat's Little Theorem:** **a^(p - 1) mod p = 1** when **p** is prime and **HCF(a, p) = 1**.

9. **Wilson's Theorem:** **(p - 1)! mod p = (p - 1)** or **-1** when **p** is prime.

10. For two numbers **A** and **B** , **A *B* = *HCF(A, B)* LCM(A, B)** ; **HCF of Fractions = HCF(Num) / LCM(Den)**.

11. Infinite surd **sqrt(a + sqrt(a + ...))** for **a = m(m + 1)** equals **(m + 1)** , and **sqrt(a - sqrt(a - ...))** equals **m**.

12. If a value increases by **R%** , the reduction % required to restore the original value is **[R / (100 + R)] * 100%**.

13. Net successive change of **x%** and **y%** equals **(x + y + xy/100)%**.

14. Golden Ratio linking Cost Price (**CP**) and Marked Price (**MP**): **CP : MP = (100 - Discount%) : (100 + Profit%)**.

15. Selling two articles at the **same Selling Price (SP1 = SP2)** with **x%** gain on one and **x%** loss on the other always causes a **Net Loss of** **(x^2 / 100)%**.

16. Selling two articles at the **same Cost Price (CP1 = CP2)** with **x%** gain on one and **x%** loss on the other results in **0%** **(No Profit, No Loss)**.

17. Dishonest dealer true profit % = **[(True Weight - False Weight) / False Weight] * 100%**.

18. Two-year `CI - SI` difference = `P (R / 100)^2`; *Three-year* `CI - SI` *difference* = `P (R / 100)^2 * (3 + R / 100)`.

19. Under Compound Interest, Pascal's Triangle multipliers are `2 : 1` (2 yrs), `3 : 3 : 1` (3 yrs), and `4 : 6 : 4 : 1` (4 yrs).

20. **Mean Proportional** of `a, b` = `sqrt(ab)`; **Third Proportional** = `(b^2)/a`; **Fourth Proportional** of `a, b, c` = `(bc)/a`.

21. Repeated replacement formula: `Final Pure Liquid = Initial Volume * (1 - x / V)^n`.

22. Alligating two **Speeds (** `km/h` **)** yields the ratio of **Time (** `T1 : T2` **)**, never Distance.

23. Average of first `n` **even** natural numbers is `(n + 1)`; average of first `n` **odd** natural numbers is `n`.

24. Adding `k` consecutive integers to a series increases its arithmetic mean by `k / 2`.

25. If `A` takes `x` days more and `B` takes `y` days more than `(A + B)` together, then `Time(A + B) = sqrt(x * y)`.

26. Manpower chain rule: `(M1 D1 H1 E1) / W1 = (M2 D2 H2 E2) / W2`.

27. `1 km/h = (5 / 18) m/s` and `1 m/s = (18 / 5) km/h`.

28. Harmonic Mean Average Speed for two equal distances: `(2 S1 S2) / (S1 + S2)`.

29. Office Late/Early Distance formula: `D = [(S1 S2) / |S1 - S2|] Delta_T`.

30. Radha-Shyam after-meeting formula: `S1 / S2 = sqrt(t2 / t1)` and `Meeting Time = sqrt(t1 * t2)`.

31. Boats & Streams: `Boat Speed u = (Downstream + Upstream) / 2`; `Stream Speed v = (Downstream - Upstream) / 2`.

32. `(a + b)^2 + (a - b)^2 = 2(a^2 + b^2)` and `(a + b)^2 - (a - b)^2 = 4ab`.

33. `a^3 + b^3 + c^3 = 3abc` when `a + b + c = 0` or `a = b = c`.

34. If `x + 1/x = k`, then `x^2 + 1/x^2 = k^2 - 2` and `x^3 + 1/x^3 = k^3 - 3k`.

35. If `x - 1/x = k`, then `x^2 + 1/x^2 = k^2 + 2` and `x^3 - 1/x^3 = k^3 + 3k`.

36. Special Reciprocal Roots: `x + 1/x = 2 => x = 1`; `x + 1/x = 1 => x^3 = -1`; `x + 1/x = sqrt(3) => x^6 = -1`.

37. For `ax^2 + bx + c = 0`, **Sum of roots** = `-b / a` and **Product of roots** = `c / a`.

38. Extreme value of `ax^2 + bx + c` is `(4ac - b^2) / (4a)` occurring at `x = -b / (2a)`.

39. If `sec(theta) + tan(theta) = k`, then `sec(theta) - tan(theta) = 1 / k` and `sin(theta) = (k^2 - 1) / (k^2 + 1)`.

40. When `A + B = 90 deg`, `tan A * tan B = 1` and `sin^2(A) + sin^2(B) = 1`.

41. When `A + B = 45 deg`, `(1 + tan A)(1 + tan B) = 2`.

42. Maximum and Minimum of `asin(theta) + bcos(theta)` are `+sqrt(a^2 + b^2)` and `-sqrt(a^2 + b^2)`.

43. Minimum value of `atan^2(theta) + bcot^2(theta)` is `2 sqrt(a b)`.

44. In a `30 deg - 60 deg - 90 deg` triangle, sides opposite to `30 deg : 60 deg : 90 deg` are in the ratio `1 : sqrt(3) : 2`.

45. For a `30 deg` to `60 deg` elevation change over distance `d`, `Tower Height H = (sqrt(3) / 2) * d`.

46. Sum of interior angles of an `n`-gon = `(n - 2) * 180 deg`; sum of exterior angles = `360 deg`; Diagonals = `n(n - 3) / 2`.

47. Angle at **Incenter** `I` = `90 deg + A/2`; at **Circumcenter** `O` = `2A`; at **Orthocenter** `H` = `180 deg - A`.

48. The **Centroid (** `G` **)** divides each median in a `2 : 1` ratio and divides the Euler Line in `HG : GO = 2 : 1`.

49. In a Right Triangle (`P, B, H`), `Inradius r = (P + B - H) / 2` and `Circumradius R = H / 2`.

50. For Similar Triangles with side ratio `a : b`, the **Area Ratio is** `a^2 : b^2`.

51. **Tangent-Secant Theorem:** `PT^2 = PA *PB*` ; ***Intersecting Chords:*** `*PA*` PB = PC * PD.

52. Direct Common Tangent `L_DCT = sqrt[d^2 - (r1 - r2)^2]` ; for externally touching circles, `L_DCT = 2 *sqrt(r1 r2)*`.

53. In an Equilateral Triangle of side `a`, `Height = (sqrt(3)/2)*a*`, `*Area* = (*sqrt*(3)/4)` a^2, and `R : r = 2 : 1`.

54. In a Rhombus with side `a` and diagonals `d1, d2`, `Area = (1/2)*d1*d2` and `4 * a^2 = (d1)^2 + (d2)^2`.

55. For a Cube of edge `a`, `Volume = a^3`, `TSA = 6*a*^2`, *and* `*Body Diagonal* = *a*` `sqrt(3)`.

56. **Total Surface Area of a Solid Hemisphere** of radius `r` is `3 *pi* r^2` (`CSA = 2 *pi* r^2`).

57. Karl Pearson's Empirical Formula: `Mode = 3 *Median* - 2 Mean`.

58. Adding a constant `k` to every observation shifts the **Mean and Median by** `+k`, but leaves **Standard Deviation and Variance unchanged (** `0` **change)**.

59. `Coefficient of Variation (CV) = (Standard Deviation / Mean) * 100%` ; Variance of first `n` natural numbers = `(n^2 - 1) / 12`.

60. In Pie Charts, `100% = 360 degrees` (`1% = 3.6 deg`), as compiled in IUC Academy Quantitative Notes and NCERT Mathematics.

IUC Academy *1-3-7-21* Day Spaced-Revision & Self-Assessment Tracker (www.iucacademy.com)

Chapter / Study Section	Day 1 (First Read)	Day 3 (Active Recall)	Day 7 (MCQ Drill)	Day 21 (Exam Ready)
1. Chapter 1: Number System, Divisibility, Remainder Theorems, HCF-LCM & Surds	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
2. Chapter 2: Percentage, Profit-Loss-Discount & Simple/Compound Interest	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
3. Chapter 3: Ratio & Proportion, Mixture-Alligation, Partnership & Averages	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
4. Chapter 4: Time & Work, Pipes & Cisterns, Time-Speed-Distance, Trains, Boats & Races	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
5. Chapter 5: Algebra — Polynomials, Quadratic Equations & High-Speed Identities	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
6. Chapter 6: Trigonometry, Trigonometric Identities, Maxima-Minima & Heights and Distances	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
7. Chapter 7: Geometry (Triangles, Centers, Similarity, Circles & Polygons) & Coordinate Geometry	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
8. Chapter 8: Mensuration (2D & 3D), Statistics, Probability, P&C & Data Interpretation	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
9. Solved Exam Practice Questions (MCQs)	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
10. Extended Comparative & Analytical Practice Set (Questions 36–75)	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
11. Rapid-Fire Last-Minute One-Liner Revision Capsule	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**