Simplification

~ Quantitative Aptitude · SSC Exams ~

← circled = key info!

Simplification is about the right order of operations. Follow **VBODMAS**, use **identities & index laws** as shortcuts, and never mix up brackets.

① VBODMAS — the Golden Order

Work strictly top-to-bottom in this order:

V — **Vinculum** / bar $\overline{a-b}$ → solve what is under the bar **first**.

B — **Brackets** in order ( ) → { } → [ ] (small → curly → square)

O — **Of** ("of" means ×, but done before ÷)

D — **Division** ÷ & **M** — **Multiplication** × (whichever comes first, left → right)

A — **Addition** + & **S** — **Subtraction** − (whichever comes first, left → right)

D & M share one rank; A & S share one rank. Never do all × before all ÷ — move strictly **left** to right.

Worked example — $12 + 6 \text{ of } 3 \div 2 \times 4 - [8 - \{5 - (3 - 1)\}]$

Step 1 (B) — $(3 - 1) = 2$ → $\{5 - 2\} = 3$ → $[8 - 3] = $ **5**. Now: $12 + 6 \text{ of } 3 \div 2 \times 4 - 5$.

Step 2 (O) — 6 **of** $3 = 18$. Now: $12 + 18 \div 2 \times 4 - 5$.

Step 3 (D&M, L→R) — $18 \div 2 = 9$, then $9 \times 4 = 36$. Now: $12 + 36 - 5$.

Step 4 (A&S, L→R) — $12 + 36 = 48$, then $48 - 5 =$ **43**. ✅

Vinculum first — $20 \div \overline{5 - 3} + 4$

Bar over $5 - 3$ → solve it first = **2**. Now $20 \div 2 + 4 = 10 + 4 =$ **14**. Without the bar it would wrongly read $20 \div 5 - 3 + 4 = 5$.

② Brackets, Signs & "Of" ( )

When a bracket is opened, the sign in front **controls every term** inside it.

Expression	Opens to
$+(a+b)$	$a+b$ signs unchanged
$+(a-b)$	$a-b$
$-(a+b)$	$-a-b$ both flip
$-(a-b)$	$-a+b$ both flip
$k(a+b)$	$ka+kb$ distribute the factor

✓ "Of" = **multiplication**, but it has **higher priority than** ÷. So "1/2 of 8 ÷ 2" = (1/2 of 8) ÷ 2 = 4 ÷ 2 = **2**, not 1/2 of 4.

Worked example — $25 - [20 - \{10 - (7 - 5)\}]$

( ) — $7 - 5 = 2 \rightarrow 25 - [20 - \{10 - 2\}]$.

{ } — $10 - 2 = 8 \rightarrow 25 - [20 - 8]$.

[ ] — $20 - 8 = 12 \rightarrow 25 - 12 =$ **13**. ✅

Worked example — 1/2 of $4 + 3 \times (6 - 2) - 8 \div 4$

B — $(6 - 2) = 4$.

O — 1/2 of 4 = 2. Now: $2 + 3 \times 4 - 8 \div 4$.

D&M — $3 \times 4 = 12$, $8 \div 4 = 2$. Now: $2 + 12 - 2$.

A&S — $2 + 12 - 2 =$ **12**. ✅

Careless sign flips cost easy marks. Rewrite **−(a−b)** as **−a+b before** you start adding — do it on paper, not in your head.

Try these

$18 - (6 - 4) + 3 =$ **19**

$-(5 - 9) + 2 =$ **6**

2 of $3 \times 4 - 5 =$ **19**

$40 \div \overline{2 + 3} \times 2 =$ **16**

③ Fractions %

Four operations

- **Add / Subtract** → take **LCM** of denominators: $a/b \pm c/d = (a \cdot d \pm c \cdot b) \ / \ (\text{LCM})$.
- **Multiply** → $a/b \times c/d = (a \times c) \ / \ (b \times d)$ (cancel first!)
- **Divide** → $a/b \div c/d = a/b \times \mathbf{d/c}$ (invert & multiply)
- **Compare** → cross-multiply: a/b vs c/d → compare $\mathbf{a \cdot d}$ with $\mathbf{b \cdot c}$.

Worked — 3/4 + 5/6 − 2/3

Step 1 — LCM(4, 6, 3) = **12**.

Step 2 — 9/12 + 10/12 − 8/12.

Answer → (9 + 10 − 8)/12 = **11/12**. ✅

Multiply — 3/4 × 8/9
cancel: 3/9 = 1/3, 8/4 = 2/1
= (1 × 2)/(1 × 3) = **2/3**.

Divide — 3/5 ÷ 9/10
invert: 3/5 × 10/9
= 30/45 = **2/3**.

Compare — which is greater, 5/7 or 7/9 ?

Cross-multiply: 5 × 9 = 45 vs 7 × 7 = 49.

49 > 45 ∴ **7/9 > 5/7**. ✅ (the side with the bigger cross-product wins)

💡 Same **numerator** → the fraction with the **smaller denominator** is larger (3/5 > 3/7). Same **denominator** → bigger numerator wins.

Try these

1/2 + 1/3 + 1/6 = **1**

7/8 ÷ 7/4 = **1/2**

2/3 × 9/10 = **3/5**

greater: 4/9 or 5/11 → **5/11**

④ Algebraic Identities

- $(a + b)^2 = a^2 + 2ab + b^2$
- $(a - b)^2 = a^2 - 2ab + b^2$
- $a^2 - b^2 = (a + b)(a - b)$
- $a^2 + b^2 = (a + b)^2 - 2ab$
- $(a + b)^3 = a^3 + b^3 + 3ab(a + b)$
- $(a - b)^3 = a^3 - b^3 - 3ab(a - b)$
- $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$
- $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$
- $a^3 + b^3 + c^3 - 3abc = (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca)$
- if $a + b + c = 0 \rightarrow a^3 + b^3 + c^3 = \mathbf{3abc}$

Worked — find 99^2 without long multiplication

Step 1 — write $99 = (100 - 1)$, use $(a - b)^2$.

Step 2 — $100^2 - 2 \cdot 100 \cdot 1 + 1^2 = 10000 - 200 + 1$.

Answer → **9801**. ✅

$43^2 - 37^2$
$= (43 + 37)(43 - 37)$
$= 80 \times 6 =$ **480**.

105×95
$= (100 + 5)(100 - 5)$
$= 10000 - 25 =$ **9975**.

Worked — if $a + b = 7$ and $ab = 12$, find $a^2 + b^2$

$a^2 + b^2 = (a + b)^2 - 2ab = 7^2 - 2 \times 12 = 49 - 24 =$ **25**. ✅

See a number ending in 9, 8, 1, 2? Rewrite near a round base: 98 = (100−2), 52 = (50+2). Identities turn "hard" squares into 2-step mental maths.

Try these

$101^2 =$ **10201**

$68^2 - 32^2 =$ **3600**

$7^3 + 3^3 \rightarrow (10)(49-21+9)=$**370**

if $a+b+c=0$: sum of cubes = **3abc**

⑤ Laws of Indices a^n

- $a^m \cdot a^n = a^{m+n}$
- $a^m / a^n = a^{m-n}$
- $(a^m)^n = a^{mn}$
- $(a \cdot b)^n = a^n \cdot b^n$ & $(a/b)^n = a^n/b^n$
- $a^0 = 1 \quad (a \neq 0)$
- $a^{-n} = 1/a^n$
- $a^{1/n} = \sqrt[n]{a}$ & $a^{m/n} = \sqrt[n]{(a^m)}$

Worked — $(3^4 \times 3^2)/3^3$

Step 1 — top: $3^4 \cdot 3^2 = 3^{4+2} = 3^6$.

Step 2 — $3^6 / 3^3 = 3^{6-3} = 3^3$.

Answer → $3^3 =$ **27**. ✅

$16^{3/4}$

$= (2^4)^{3/4} = 2^3$

$=$ **8**.

$27^{-2/3}$

$= (3^3)^{-2/3} = 3^{-2}$

$=$ **1/9**.

Solve for x — $2^x = 32$

$32 = 2^5 \therefore 2^x = 2^5$. Equal bases → equate powers → **$x = 5$**. ✅

*Powers add on **multiply**, subtract on **divide**, multiply on **power-of-a-power**. Always rewrite every term to a **common base** first.*

Try these

$5^7 / 5^5 =$ **25**

$(2^3)^2 =$ **64**

$8^{2/3} =$ **4**

$7^0 + 3^{-1} =$ **4/3**

⑥ Surds & Rationalisation $\sqrt{\ }$

- $\sqrt{a} \cdot \sqrt{b} = \sqrt{ab}$ & $\sqrt{a} / \sqrt{b} = \sqrt{a/b}$
- $(\sqrt{a})^2 = a$ & $\sqrt{a^2 b} = a\sqrt{b}$ (pull out perfect squares)
- **Conjugate** of $(\sqrt{a} + \sqrt{b})$ is $(\sqrt{a} - \sqrt{b})$; their product $= a - b$ (no surd left).
- **Rationalise** $1/(\sqrt{a} + \sqrt{b}) \rightarrow$ multiply top & bottom by $(\sqrt{a} - \sqrt{b})$.

Worked — rationalise $1/(\sqrt{3} + \sqrt{2})$

Step 1 — multiply by conjugate $(\sqrt{3} - \sqrt{2})/(\sqrt{3} - \sqrt{2})$.

Step 2 — denominator $= (\sqrt{3})^2 - (\sqrt{2})^2 = 3 - 2 = 1$.

Answer $\rightarrow (\sqrt{3} - \sqrt{2})/1 = \boldsymbol{\sqrt{3} - \sqrt{2}}$. ✅

Worked — simplify $\sqrt{12} + \sqrt{27} - \sqrt{48}$

$\sqrt{12} = 2\sqrt{3}$, $\sqrt{27} = 3\sqrt{3}$, $\sqrt{48} = 4\sqrt{3} \rightarrow 2\sqrt{3} + 3\sqrt{3} - 4\sqrt{3} = \boldsymbol{\sqrt{3}}$. ✅

Keep handy: $\sqrt{2} \approx$ **1.414**, $\sqrt{3} \approx$ **1.732**, $\sqrt{5} \approx$ **2.236**, $\sqrt{7} \approx$ **2.646**. Great for "approximate value" surd questions.

⑦ Recurring Decimals → Fractions

- $0.\overline{a} = a/9$ · $0.\overline{ab} = ab/99$ · $0.\overline{abc} = abc/999$
- **Mixed** $\rightarrow 0.a\overline{b} = (ab - a) / 90$ (9 for each recurring digit, 0 for each non-recurring)

Worked — 0.3636... and 0.1666...

- $0.\overline{36} = 36/99 = \mathbf{4/11}$ (divide by 9).
- $0.1\overline{6} = (16 - 1)/90 = 15/90 = \mathbf{1/6}$. ✅

⑧ Square & Cube Root Tricks

Unit-digit map (perfect squares)

square ends 1 → root ends **1 / 9** · ends 4 → **2 / 8** · ends 9 → **3 / 7** · ends 6 → **4 / 6** · ends 5 → **5** · ends 0 → **0**.

(a square **never** ends in 2, 3, 7 or 8)

Worked — $\sqrt{1849}$

Step 1 — unit digit 9 → root ends in **3 or 7**.

Step 2 — drop last two digits → 18. Largest square ≤ 18 is $16 = 4^2$ → tens digit **4**.

Step 3 — $4 \times (4+1) = 20$; since $18 < 20$, take the **smaller** option → 3.

Answer → **43** (check $43^2 = 1849$). ✅

Cube root by grouping

Group digits in **3's from the right**. Last group's unit digit gives root's unit (1→1, 8→**2**, 7→**3**, 4→4, 5→5, 6→6, 3→**7**, 2→**8**, 9→9, 0→0). Left group → largest cube ≤ it gives the tens digit.

Worked — $\sqrt[3]{19683}$

Groups: **19 | 683**. Last group ends in 3 → unit digit **7**. Left = 19; largest cube ≤ 19 is $8 = 2^3$ → tens **2**. ∴ **27** ($27^3 = 19683$). ✅

Nested surd → $\sqrt{a + \sqrt{a + \dots\infty}} = [1 + \sqrt{1+4a}]/2$. So $\sqrt{20 + \sqrt{20 + \dots}} = (1+9)/2 = 5$.
Product form $\sqrt{x\sqrt{x\dots\infty}} = x$.

⑨ Approximation

- **Round** each term to an easy number (64.9 → 65, 24.97% → 25%).
- Replace √ and squares by nearest perfect value; the answer is the **closest option**.

Worked — $\sqrt{4096} + (15.02)^2 - 124.9 \div 5$

$\sqrt{4096} = 64$ · $(15.02)^2 \approx 225$ · $124.9 \div 5 \approx 25$ → $64 + 225 - 25 \approx$ **264**. ✅

Practice Set

1. $8 + 2$ of $3 - 4 \div 2 = ?$
2. $15 - [8 - \{6 - (4 - 2)\}] = ?$
3. $3/4 + 1/6 - 1/3 = ?$
4. $5/8 \div 15/16 = ?$
5. $96^2 = ?$ (use identity)
6. $87 \times 93 = ?$
7. $(2^5 \times 2^3) / 2^6 = ?$
8. $32^{2/5} = ?$
9. rationalise $1/(\sqrt{7} - \sqrt{6})$
10. $0.4545...$ as a fraction $= ?$
11. $\sqrt{2916} = ?$
12. $\sqrt[3]{4096} = ?$

Answer Key — with working

1→ 12 (2 of 3=6; 4÷2=2; 8+6−2) · **2→ 11** ((4−2)=2; {6−2}=4; [8−4]=4; 15−4) · **3→ 7/12** (9+2−4 over 12) · **4→ 2/3** (5/8 × 16/15) · **5→ 9216** ($(100-4)^2=10000-800+16$) · **6→ 8091** ($(90-3)(90+3)=8100-9$) · **7→ 4** ($2^{5+3-6}=2^2$) · **8→ 4** ($(2^5)^{2/5}=2^2$) · **9→ $\sqrt{7}+\sqrt{6}$** (× conjugate; 7−6=1) · **10→ 5/11** (45/99) · **11→ 54** (ends 4/6; $29>25=5^2$, 5×6=30>29→4) · **12→ 16** ($16^3=4096$).

Quick Revision

- ✓ **VBODMAS** → Vinculum, Brackets ( )→{ }→[ ], Of, Division & Multiplication (L→R), Addition & Subtraction (L→R).
- ✓ $-(a-b)=-a+b$ · $a^2-b^2=(a+b)(a-b)$ · $a^2+b^2=(a+b)^2-2ab$ · $a^m \cdot a^n=a^{m+n}$.
- ✓ Divide by inverting fractions · rationalise by the conjugate · $0.\overline{ab}=ab/99$ · roots by unit-digit / grouping.

✓ Golden rule → **solve in order, not left-to-right blindly.** One wrong step in the sequence flips the whole answer.

☆ Follow VBODMAS — simplify with confidence! ☆