Surds & Indices

~ Quantitative Aptitude · SSC Exams ~

← circled = key formulas!

Surds & Indices power up algebra, simplification & number-system questions. Master the laws of exponents & surd manipulation — dozens of SSC questions collapse to one line once you know these tricks.

① Laws of Indices — the Building Blocks

In a^m, **a** is the **base** and **m** is the **index / power / exponent**. These laws work only when the bases are the **same** (or can be made the same).

The four core laws

- $a^m \cdot a^n = a^{m+n}$ (same base → add powers)
- $a^m \div a^n = a^{m-n}$ (same base → subtract powers)
- $(a^m)^n = a^{mn}$ (power of a power → multiply)
- $(ab)^n = a^n b^n$ · $(a/b)^n = a^n/b^n$

Worked example — simplify $(2^3 \cdot 2^4) \div 2^5$

Step 1 — combine the numerator: $2^3 \cdot 2^4 = 2^{3+4} = 2^7$.

Step 2 — divide: $2^7 \div 2^5 = 2^{7-5} = 2^2$.

Answer → = **4**. ✅

Try these

$5^2 \cdot 5^3 = 5^5 =$ **3125**

$x^7/x^3 =$ $\mathbf{x^4}$

$(3^2)^3 = 3^6 =$ **729**

$(2\times3)^4 = 2^4\times3^4 =$ **1296**

Laws apply **only when the base is identical** — $2^3 \cdot 3^2$ can NOT be combined into one power. Different bases must first be rewritten with a common base.

② Zero, Negative & Fractional Indices ⇄

Learn these by heart

- $a^0 = 1$ $(a \neq 0)$ · $a^{-n} = 1/a^n$ (negative index → reciprocal)
- $a^{1/n} = \sqrt[n]{a}$ (the n-th root of a)
- $a^{m/n} = (\sqrt[n]{a})^m = \sqrt[n]{(a^m)}$

Worked example – evaluate $8^{2/3}$

Step 1 — write 8 as a power of 2: $8 = 2^3$.
Step 2 — $(2^3)^{2/3} = 2^{3\times 2/3} = 2^2$.
Answer → = 4. ✅

Worked example – evaluate $27^{-2/3}$

Step 1 — $27^{2/3} = (3^3)^{2/3} = 3^2 = 9$.
Step 2 — negative index → take the reciprocal: $1/9$.
Answer → = $1/9$. ✅

Laws of Indices – quick reference table

Rule name	Statement
Product	$a^m \cdot a^n = a^{m+n}$
Quotient	$a^m / a^n = a^{m-n}$
Power of power	$(a^m)^n = a^{mn}$
Power of product	$(ab)^n = a^n b^n$
Power of quotient	$(a/b)^n = a^n / b^n$
Zero index	$a^0 = 1$
Negative index	$a^{-n} = 1/a^n$
Fractional index	$a^{1/n} = \sqrt[n]{a}$
General fractional	$a^{m/n} = \sqrt[n]{(a^m)}$

💡 $a^0 = 1$ holds for EVERY nonzero a, even $999999^0 = 1$. But 0^0 is undefined – a common exam trap.

③ Solving Exponential Equations ⚖

The golden rule

When the bases match (or can be forced to match), just **equate the powers**: if $a^x = a^y$, then $\boldsymbol{x = y}$ ($a > 0$, $a \neq 1$).

Worked example — solve $2^{x+1} = 32$

Step 1 — write 32 as a power of 2: $32 = 2^5$.

Step 2 — equate powers: $x+1 = 5$.

Answer → $\boldsymbol{x = 4}$. ✅

Worked example — solve $3^{2x-1} = 1/27$

Step 1 — $1/27 = 3^{-3}$.

Step 2 — equate: $2x-1 = -3 \Rightarrow 2x = -2$.

Answer → $\boldsymbol{x = -1}$. ✅

Worked example — solve $9^x = 3^{x+1}$

Step 1 — $9 = 3^2 \Rightarrow 3^{2x} = 3^{x+1}$.

Step 2 — equate: $2x = x+1$.

Answer → $\boldsymbol{x = 1}$. ✅

Try these

$4^x = 64 \rightarrow$ $\boldsymbol{x = 3}$

$5^{x-1} = 25 \rightarrow$ $\boldsymbol{x = 3}$

$2^{3x} = 1/8 \rightarrow$ $\boldsymbol{x = -1}$

$16^x = 4^{x+1} \rightarrow$ $\boldsymbol{x = 1}$

💡 If bases look different but are related (like 9 & 3, or 8 & 2, or 16 & 4), rewrite everything as a power of the **smallest common base** first.

④ Introduction to Surds $\sqrt{\ }$

An irrational number of the form $\sqrt[n]{a}$ ($n \geq 2$, a rational, and $\sqrt[n]{a}$ irrational) is called a **SURD**.
The **order** of a surd is its root index n.

Types you must know

- **Pure surd** — rational coefficient is 1: $\sqrt{7}$, $\sqrt[3]{11}$.
- **Mixed surd** — a rational number × a surd: $3\sqrt{7}$, $2\sqrt[3]{5}$.
- **Like surds** — same order AND same radicand: $2\sqrt{3}$ and $5\sqrt{3}$.
- **Unlike surds** — different order or radicand: $2\sqrt{3}$ & $2\sqrt{5}$, or $\sqrt{3}$ & $\sqrt[3]{3}$.

Worked example — classify $4\sqrt{5}$, $\sqrt{9}$, $\sqrt[3]{12}$, 6

$4\sqrt{5}$ → mixed surd (order 2). **$\sqrt{9}$** → $= 3$, rational — **NOT a surd**.
$\sqrt[3]{12}$ → pure surd (order 3). **6** → rational, not a surd. ✅

Try these — find the order

$\sqrt{20}$ → order **2** (a genuine surd)

$\sqrt[5]{2}$ → order **5**

$\sqrt[4]{81} = \sqrt[4]{(3^4)} = \mathbf{3}$ — not a surd!

$\sqrt[3]{-8} = \mathbf{-2}$ — not a surd!

Always check if the number under the root is a **perfect power of that order** — if yes, it simplifies to a rational number and STOPS being a surd.

Every surd is irrational, but NOT every irrational number is a surd (e.g. **π** is irrational but not a surd).

⑤ Operations on Surds + −

The rules

- **Add / Subtract** — only **LIKE surds** combine: add/subtract their coefficients.
- **Multiply / Divide** — same order: $\sqrt[n]{a} \times \sqrt[n]{b} = \sqrt[n]{ab}$. Different order → convert to the LCM order first.

Worked example – simplify $3\sqrt{2} + 5\sqrt{2} - \sqrt{2}$

Step 1 — all three are LIKE surds (order 2, radicand 2).

Step 2 — combine coefficients: $(3+5-1)\sqrt{2}$.

Answer → $= 7\sqrt{2}$. ✅

Worked example – simplify $\sqrt{12} + \sqrt{27}$

Step 1 — simplify each first: $\sqrt{12} = 2\sqrt{3}$, $\sqrt{27} = 3\sqrt{3}$.

Step 2 — now they're LIKE surds: $2\sqrt{3} + 3\sqrt{3}$.

Answer → $= 5\sqrt{3}$. ✅

Try these

$\sqrt{8}+\sqrt{18} = 2\sqrt{2}+3\sqrt{2} =$ **$5\sqrt{2}$**

$\sqrt{5}\times\sqrt{20} = \sqrt{100} =$ **10**

$4\sqrt{3}-\sqrt{3} =$ **$3\sqrt{3}$**

$\sqrt{48}/\sqrt{3} = \sqrt{16} =$ **4**

ALWAYS simplify each surd to its lowest form first – $\sqrt{12}$ and $\sqrt{27}$ look unlike, but become $2\sqrt{3}$ and $3\sqrt{3}$, which ARE like surds.

✓ $\sqrt{3}\times\sqrt{12}=\sqrt{36}=6$ – two surds can multiply to give a rational number!

⑥ Comparing Surds >|

To compare surds of **different order**, convert them to the **same order** (the LCM of the orders), then compare the radicands — bigger radicand = bigger surd.

Worked example — compare $\sqrt[3]{5}$ and $\sqrt{3}$

Step 1 — LCM of orders 3 and 2 = 6.

Step 2 — $\sqrt[3]{5} = 5^{2/6} = \sqrt[6]{25}$; $\sqrt{3} = 3^{3/6} = \sqrt[6]{27}$.

Answer → 27 > 25, so $\sqrt{3} > \sqrt[3]{5}$. ✅

Worked example — compare $2\sqrt{3}$ and $3\sqrt{2}$ (same order)

Step 1 — same order 2, so just square both: $(2\sqrt{3})^2 = 4\times3 = 12$.

Step 2 — $(3\sqrt{2})^2 = 9\times2 = 18$.

Answer → 18 > 12, so $3\sqrt{2} > 2\sqrt{3}$. ✅

Try this

Compare $\sqrt{7}$ and $\sqrt[3]{26}$ → LCM(2,3)=6: $\sqrt{7} = \sqrt[6]{343}$; $\sqrt[3]{26} = \sqrt[6]{676}$. Since 676 > 343 → $\sqrt[3]{26} > \sqrt{7}$.

Surds with the **same order** but a rational coefficient (like $2\sqrt{3}$ vs $3\sqrt{2}$)? Just square each — no need for LCM of orders at all.

Bigger order, same radicand → SMALLER value! E.g. $\sqrt[3]{8} = 2$ but $\sqrt[2]{8} \approx 2.83$ — more roots pull the value down.

⑦ Rationalising – Simple Surd Denominator √→

To remove a surd from the denominator, multiply **numerator & denominator by that same surd**, since $\sqrt{a} \times \sqrt{a} = a$ (rational).

Worked example – rationalise $1/\sqrt{3}$

Step 1 — multiply top & bottom by $\sqrt{3}$.

Step 2 — $(1\times\sqrt{3}) / (\sqrt{3}\times\sqrt{3}) = \sqrt{3}/3$.

Answer → = $\sqrt{3}/3$. ✅

Worked example – rationalise $5/(2\sqrt{3})$

Step 1 — multiply top & bottom by $\sqrt{3}$.

Step 2 — $5\sqrt{3}/(2\times3) = 5\sqrt{3}/6$.

Answer → = $5\sqrt{3}/6$. ✅

Worked example – rationalise $7/\sqrt{50}$

Step 1 — simplify $\sqrt{50} = 5\sqrt{2}$ first.

Step 2 — $7/(5\sqrt{2}) \times \sqrt{2}/\sqrt{2} = 7\sqrt{2}/10$.

Answer → = $7\sqrt{2}/10$. ✅

Try these

$1/\sqrt{5}$ = $\sqrt{5}/5$

$3/\sqrt{7}$ = $3\sqrt{7}/7$

$4/(3\sqrt{2})$ = $2\sqrt{2}/3$

$2/\sqrt{18}$ = $\sqrt{2}/3$

💡 Simplify the surd in the denominator first ($\sqrt{50} \to 5\sqrt{2}$) – rationalising a smaller surd is much faster.

⑧ Rationalising with Conjugates $^{+}_{-}$

When the denominator has TWO terms like $(a + \sqrt{b})$, multiply by its **conjugate** $(a - \sqrt{b})$: $(a+\sqrt{b})(a-\sqrt{b}) = \mathbf{a^2 - b}$.

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

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

Step 2 — denominator $= 2^2-(\sqrt{3})^2 = 4-3 = 1$.

Answer → $=$ **$2-\sqrt{3}$**. ✅

Worked example — rationalise $1/(\sqrt{5}+\sqrt{3})$

Step 1 — multiply by conjugate $(\sqrt{5}-\sqrt{3})$.

Step 2 — denominator $= 5-3 = 2$.

Answer → $=$ **$(\sqrt{5}-\sqrt{3})/2$**. ✅

Worked example — rationalise $4/(3-\sqrt{5})$

Step 1 — multiply by conjugate $(3+\sqrt{5})$.

Step 2 — denominator $= 9-5 = 4$; numerator $= 4(3+\sqrt{5})$.

Answer → $=$ **$3+\sqrt{5}$**. ✅

Try these

$1/(4+\sqrt{7}) =$ **$(4-\sqrt{7})/9$**

$1/(\sqrt{6}-\sqrt{2}) =$ **$(\sqrt{6}+\sqrt{2})/4$**

The conjugate just flips the sign between the two terms: $(a+\sqrt{b}) \leftrightarrow (a-\sqrt{b})$ or $(\sqrt{a}+\sqrt{b}) \leftrightarrow (\sqrt{a}-\sqrt{b})$.

✓ Given $x = 2+\sqrt{3}$, its reciprocal $1/x$ rationalises instantly to $2-\sqrt{3}$ (needed on page 14 for $x+1/x$).

⑨ Simplifying Nested Surds $\sqrt{(a \pm 2\sqrt{b})}$

The rule

Write the middle term as $2\sqrt{y}$. Find m, n such that $m+n = x$ and $mn = y$ $(m > n > 0)$.

$\therefore \sqrt{(x+2\sqrt{y})} = \sqrt{m} + \sqrt{n}$ · $\sqrt{(x-2\sqrt{y})} = \sqrt{m} - \sqrt{n}$

Worked example – simplify $\sqrt{(7+4\sqrt{3})}$

Step 1 — write $4\sqrt{3}$ as $2\sqrt{12}$ (so $y = 12$).

Step 2 — find m,n: $m+n = 7$, $mn = 12 \Rightarrow m=4$, $n=3$.

Answer → $\sqrt{4} + \sqrt{3} =$ **$2 + \sqrt{3}$**. ✅ (check: $(2+\sqrt{3})^2=7+4\sqrt{3}$ ✓)

Worked example – simplify $\sqrt{(5-2\sqrt{6})}$

Step 1 — already $2\sqrt{y}$ form, $y = 6$.

Step 2 — $m+n = 5$, $mn = 6 \Rightarrow m=3$, $n=2$.

Answer → = **$\sqrt{3} - \sqrt{2}$**. ✅

Try these

$\sqrt{(9+4\sqrt{5})} = \sqrt{5}+\sqrt{4} =$ **$2+\sqrt{5}$** $(m+n=9,\ mn=20 \Rightarrow m=5, n=4)$

$\sqrt{(11-2\sqrt{30})} =$ **$\sqrt{6}-\sqrt{5}$** $(m+n=11,\ mn=30 \Rightarrow m=6, n=5)$

If the middle term isn't already "$2\sqrt{\ }$ something", rewrite it first – e.g. $4\sqrt{3} = 2\times2\sqrt{3} = 2\sqrt{(4\times3)} = 2\sqrt{12}$.

⑩ Infinite (Recurring) Nested Surds ∞

The pattern inside $\sqrt{x+\sqrt{x+\sqrt{x+\dots}}}$ repeats itself forever, so the WHOLE expression (call it y) sits inside itself: $\mathbf{y = \sqrt{x+y}}$.

The rule

Square both sides: $y^2 = x+y \Rightarrow \mathbf{y^2 - y - x = 0}$. Solve the quadratic; take the **POSITIVE** root.

Worked example – find $\sqrt{6+\sqrt{6+\sqrt{6+\dots}}}$

Step 1 — let $y = \sqrt{6+y} \Rightarrow y^2 = 6+y \Rightarrow y^2-y-6 = 0$.

Step 2 — factorise: $(y-3)(y+2) = 0 \Rightarrow y = 3$ or $y = -2$.

Answer → reject negative $\Rightarrow$ $\mathbf{y = 3}$. ✅

Worked example – find $\sqrt{12+\sqrt{12+\sqrt{12+\dots}}}$

Step 1 — $y^2-y-12 = 0$.

Step 2 — $(y-4)(y+3) = 0$.

Answer → $\mathbf{y = 4}$. ✅

Try these

$\sqrt{20+\sqrt{20+\dots}} = \mathbf{5}$

$\sqrt{2+\sqrt{2+\dots}} = \mathbf{2}$

Shortcut → for $\sqrt{x+\sqrt{x+\dots}}$, if $x = n(n-1)$ for some integer n, the answer is simply $\mathbf{n}$. E.g. $x=6=3\times2 \Rightarrow y=3$; $x=12=4\times3 \Rightarrow y=4$.

⑪ $x + 1/x$ Type — the Squaring Trick

Given $x + 1/x = k$ ...

- $x^2 + 1/x^2 = \mathbf{k^2 - 2}$ · $x^3 + 1/x^3 = \mathbf{k^3 - 3k}$
- $(x - 1/x)^2 = k^2 - 4 \Rightarrow x - 1/x = \pm\sqrt{(k^2-4)}$
- If instead $x - 1/x = k$, then $x^2 + 1/x^2 = \mathbf{k^2 + 2}$.

Worked example — if $x + 1/x = 4$, find x^2+1/x^2 and x^3+1/x^3

Step 1 — $x^2+1/x^2 = 4^2-2 = 16-2 = \mathbf{14}$.

Step 2 — $x^3+1/x^3 = 4^3-3(4) = 64-12 = \mathbf{52}$. ✅

Worked example — if $x - 1/x = 3$, find x^2+1/x^2

$x^2+1/x^2 = (x-1/x)^2+2 = 9+2 = \mathbf{11}$. ✅

Try these

$x+1/x=5 \rightarrow x^2+1/x^2 = \mathbf{23}$

$x-1/x=4 \rightarrow x^2+1/x^2 = \mathbf{18}$

$x+1/x=3 \rightarrow x^3+1/x^3 = \mathbf{18}$

$x^2+1/x^2=7 \rightarrow x+1/x = \mathbf{3}$

Whenever a question gives $x+1/x$ or $x-1/x$, **SQUARE it immediately** — that's the fastest route to x^2+1/x^2.

⑫ High-Frequency SSC Shortcuts

Four "always true" identities

- $(x^a)^{b-c} \cdot (x^b)^{c-a} \cdot (x^c)^{a-b} = 1$ (exponents cancel to 0)
- If $a^x=b$, $b^y=c$, $c^z=a$ $(a,b,c \neq 0,\pm 1)$ ⇒ $xyz = 1$
- If $a^x=b^y=c^z=k$ and $abc=1$ ⇒ $1/x + 1/y + 1/z = 0$

Worked – simplify $(x^2)^{5-3} \cdot (x^5)^{3-2} \cdot (x^3)^{2-5}$

Step 1 — add the exponents: $2(2)+5(1)+3(-3) = 4+5-9 = 0$.

Answer → $x^0 = 1$. ✅

Worked – if $2^x=3$, $3^y=4$, $4^z=2$, find xyz

Matches the $a^x=b$, $b^y=c$, $c^z=a$ pattern $(a=2, b=3, c=4)$.

Answer → $xyz = 1$ (no need to find x, y, z individually!) ✅

Try these

- $\{(x^a/x^b)\}^{a+b} \cdot \{(x^b/x^c)\}^{b+c} \cdot \{(x^c/x^a)\}^{c+a} = 1$ (always, for any a, b, c)
- If $5^x=7^y=35^z$ and $5\times 7 = 35$, use the reciprocal-sum trick with abc=1 pattern where relevant.

💡 These "always 1" or "always 0" identities are a favourite SSC trap – you never need the actual values of a, b, c, x, y, z. Just recognise the pattern!

Solved Examples – Indices

Q1. Simplify $(27)^{1/3} \times (8)^{2/3}$.

$= 3 \times 4 = \mathbf{12}$. ✅

Q2. Find x if $4^x = 2^{x+3}$.

$2^{2x} = 2^{x+3} \Rightarrow 2x = x+3 \Rightarrow \mathbf{x = 3}$. ✅

Q3. Simplify $(a^2b^{-3})^2 \div (a^{-1}b^2)$.

$= a^4b^{-6} \div a^{-1}b^2 = a^{4-(-1)}b^{-6-2} = \mathbf{a^5/b^8}$. ✅

Q4. Evaluate $625^{1/4}$.

$625 = 5^4 \Rightarrow 625^{1/4} = \mathbf{5}$. ✅

Q5. Evaluate $16^{-3/4}$.

$16^{3/4} = (2^4)^{3/4} = 2^3 = 8 \Rightarrow 16^{-3/4} = \mathbf{1/8}$. ✅

Q6. Simplify $(x^{1/2} \cdot x^{1/3}) \div x^{1/6}$.

Exponent $= 1/2 + 1/3 - 1/6 = (3+2-1)/6 = 4/6 = \mathbf{x^{2/3}}$. ✅

✓ *In Q6, adding/subtracting fractional exponents needs the same LCM logic as ordinary fractions — nothing new, just index arithmetic.*

Solved Examples – Surds

Q1. Simplify $(\sqrt{5}+\sqrt{3})(\sqrt{5}-\sqrt{3})$.

$= 5 - 3 =$ **2**. ✅

Q2. Rationalise and simplify $3/(\sqrt{7}-2)$.

$\times(\sqrt{7}+2)/(\sqrt{7}+2)$: denom $= 7-4 = 3 \Rightarrow\ = 3(\sqrt{7}+2)/3 =$ **$\sqrt{7}+2$**. ✅

Q3. If $x = 2+\sqrt{3}$, find $x + 1/x$.

$1/x = 1/(2+\sqrt{3}) = 2-\sqrt{3}$ (rationalised) $\Rightarrow x+1/x = (2+\sqrt{3})+(2-\sqrt{3}) =$ **4**. ✅

Q4. Simplify $\sqrt{45} + \sqrt{20} - \sqrt{5}$.

$= 3\sqrt{5} + 2\sqrt{5} - \sqrt{5} =$ **$4\sqrt{5}$**. ✅

Q5. Find the value of $\sqrt{(6+2\sqrt{5})}$.

$m+n=6$, $mn=5 \Rightarrow m=5, n=1 \Rightarrow\ = \sqrt{5}+\sqrt{1} =$ **$\sqrt{5}+1$**. ✅

Q6. If $x - 1/x = 2\sqrt{3}$, find x^2+1/x^2.

$= (x-1/x)^2+2 = (2\sqrt{3})^2+2 = 12+2 =$ **14**. ✅

✓ Q3's trick — whenever $x = a+\sqrt{b}$, its reciprocal $1/x$ is simply $a-\sqrt{b}$ after rationalising, since $(a+\sqrt{b})(a-\sqrt{b})=a^2-b$.

Exercise

Q1. Simplify $3^5 \times 3^{-2} \div 3^0$. (a) 9 (b) 27 (c) 81 (d) 3

Q2. Value of $16^{3/4}$. (a) 4 (b) 8 (c) 16 (d) 32

Q3. If $5^{x-2} = 25$, find x. (a) 2 (b) 3 (c) 4 (d) 6

Q4. Which of these is a pure surd? (a) $3\sqrt{5}$ (b) $\sqrt{9}$ (c) $\sqrt{7}$ (d) $4\sqrt{2}$

Q5. Order of the surd $\sqrt[5]{12}$ is: (a) 2 (b) 3 (c) 5 (d) 12

Q6. Simplify $2\sqrt{3}+5\sqrt{3}-\sqrt{3}$. (a) $6\sqrt{3}$ (b) $8\sqrt{3}$ (c) $5\sqrt{3}$ (d) $6\sqrt{9}$

Q7. Rationalise $1/(3+\sqrt{2})$. (a) $(3-\sqrt{2})/7$ (b) $(3+\sqrt{2})/7$ (c) $(3-\sqrt{2})/11$ (d) $3-\sqrt{2}$

Q8. Which is greater? (a) $\sqrt[3]{4}$ (b) $\sqrt{2}$ (c) equal (d) cannot say

Q9. If $x+1/x=5$, find x^2+1/x^2. (a) 21 (b) 23 (c) 25 (d) 27

Q10. Simplify $\sqrt{(9+4\sqrt{5})}$. (a) $2+\sqrt{5}$ (b) $3+\sqrt{5}$ (c) $2+\sqrt{6}$ (d) 5+2

Q11. Find $\sqrt{(20+\sqrt{(20+\sqrt{(20+\ldots)})})}$. (a) 4 (b) 5 (c) 6 (d) 20

Q12. If $a^x=b$, $b^y=c$, $c^z=a$, find xyz. (a) 0 (b) 1 (c) −1 (d) abc

Q13. Simplify $(x^a)^{b-c}.(x^b)^{c-a}.(x^c)^{a-b}$. (a) 0 (b) 1 (c) x (d) x^{a+b+c}

Q14. If $x-1/x=3$, find x^2+1/x^2. (a) 7 (b) 9 (c) 11 (d) 13

Answer Key

1→(b)27 · 2→(b)8 · 3→(c)4 · 4→(c)$\sqrt{7}$ · 5→(c)5 · 6→(a)$6\sqrt{3}$ · 7→(a)$(3-\sqrt{2})/7$ · 8→(a)$\sqrt[3]{4}$ · 9→(b)23 · 10→(a)$2+\sqrt{5}$ · 11→(b)5 · 12→(b)1 · 13→(b)1 · 14→(c)11.

Q8 & Q12 & Q13 test whether you spot the SHORTCUT PATTERN rather than grind through algebra — exactly how SSC sets these traps.

Quick Revision

- ✓ $a^m \cdot a^n = a^{m+n}$; $a^m / a^n = a^{m-n}$; $(a^m)^n = a^{mn}$; $a^0 = 1$; $a^{-n} = 1/a^n$; $a^{1/n} = \sqrt[n]{a}$. Same base → equate powers to solve equations.
- ✓ Surd order = root index; LIKE surds share order & radicand — only these add/subtract. Different orders? Convert via LCM to compare or multiply.
- ✓ Rationalise: $1/\sqrt{a} \to \times\sqrt{a}$; $1/(a+\sqrt{b}) \to \times$conjugate$(a-\sqrt{b})$. $\sqrt{(x\pm2\sqrt{y})} = \sqrt{m}\pm\sqrt{n}$ where $m+n=x$, $mn=y$. Nested infinite → $y^2-y-x=0$.
- ✓ $x\pm1/x$ given? SQUARE it: $x^2+1/x^2 = (x+1/x)^2-2 = (x-1/x)^2+2$. "Always 1/0" identities need pattern-spotting, not calculation.

Extra Solved Examples

E1. Simplify $(2^{-1}+3^{-1})^{-1}$. → $1/2+1/3 = 5/6$; inverse = **$6/5$**. ✅

E2. Simplify $\sqrt[3]{(64x^6y^3)}$. → $\sqrt[3]{64}\cdot\sqrt[3]{(x^6)}\cdot\sqrt[3]{(y^3)}$ = **$4x^2y$**. ✅

E3. If $x+1/x=\sqrt{3}$, find x^3+1/x^3. → $k^3-3k = 3\sqrt{3}-3\sqrt{3}$ = **0**. ✅

E4. Rationalise $1/(\sqrt{2}+1)$ and simplify. → $\times(\sqrt{2}-1)/(\sqrt{2}-1)$ = **$\sqrt{2}-1$** (denom $2-1=1$). ✅

☆ Powers up, surds down — indices made simple! ☆

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