SURDS (WASSCE LEVEL)

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1. What Is a Surd?

A surd is an irrational number written in root form that cannot be simplified into a whole number.

Examples:

- $\sqrt{2}$
- $\sqrt{3}$
- $2\sqrt{5}$

Not surds:

- $\sqrt{4} = 2$
- $\sqrt{49} = 7$

Roots

2. Important Square Roots to Memorize

These are very important for WASSCE:

Number	Square Root
1	1
4	2
9	3
16	4
25	5
36	6
49	7
64	8
81	9
100	10

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3. Simplifying Surds

Rule

Find a perfect square factor inside the root.

Example 1:

$$\sqrt{12}$$

Factorize:

$$12 = 4 \times 3$$

So:

$$\sqrt{12} = \sqrt{4 \times 3}$$

Use:

$$\sqrt{ab} = \sqrt{a}\sqrt{b}$$

$$= \sqrt{4} \times \sqrt{3}$$

$$= 2\sqrt{3}$$

Final Answer:

$$2\sqrt{3}$$

Example 2

$$\sqrt{72}$$

$$72 = 36 \times 2$$

$$\sqrt{72} = \sqrt{36 \times 2}$$

$$= 6\sqrt{2}$$

Final Answer:

$$6\sqrt{2}$$

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WASSCE Shortcut

Always look for:

- 4
- 9
- 16
- 25
- 36
- 49

inside the number.

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4. Adding and Subtracting Surds

You can only add or subtract LIKE surds.

Example:

$$3\sqrt{2} + 5\sqrt{2}$$

Add coefficients only:

$$= (3 + 5)\sqrt{2}$$

$$= 8\sqrt{2}$$

Example 2

$$7\sqrt{5} - 2\sqrt{5}$$

$$= (7 - 2)\sqrt{5}$$

$$= 5\sqrt{5}$$

Example 3

$$3\sqrt{2} + 4\sqrt{3}$$

Cannot be added because roots are different.

Final Answer:

$$3\sqrt{2} + 4\sqrt{3}$$

5. Multiplying Surds

Rule

Multiply numbers outside and inside separately.

Example:

$$(2\sqrt{3})(4\sqrt{5})$$

Multiply coefficients:

$$2 \times 4 = 8$$

Multiply roots:

$$\sqrt{3} \times \sqrt{5} = \sqrt{15}$$

Answer:

$$8\sqrt{15}$$

Example 2

$$\sqrt{2} \times \sqrt{8}$$

Combine roots:

$$= \sqrt{16}$$

$$= 4$$

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6. Expanding Brackets with Surds

Example:

$$(\sqrt{2} + 3)(\sqrt{2} + 1)$$

Expand:

$$= \sqrt{2}(\sqrt{2}) + \sqrt{2}(1) + 3(\sqrt{2}) + 3(1)$$

$$= 2 + \sqrt{2} + 3\sqrt{2} + 3$$

Collect like terms:

$$= 5 + 4\sqrt{2}$$

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7. Rationalizing the Denominator

Very important in WASSCE.

You must remove surds from the denominator.

Case 1: Single Surd Denominator

Example:

$$\frac{3}{\sqrt{2}}$$

Multiply top and bottom by $\sqrt{2}$:

$$\frac{3}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}$$

$$= \frac{3\sqrt{2}}{2}$$

Final Answer:

$$\frac{3\sqrt{2}}{2}$$

Example 2

$$\frac{5}{2\sqrt{3}}$$

Multiply by $\sqrt{3}$:

$$\frac{5}{2\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$= \frac{5\sqrt{3}}{6}$$

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8. Rationalizing Using Conjugates

When denominator has two terms.

Conjugate Rule

Change the sign between the terms.

Conjugate of:

$$3 + \sqrt{2}$$

is:

$$3 - \sqrt{2}$$

Example

$$\frac{1}{2 + \sqrt{3}}$$

Multiply top and bottom by conjugate:

$$\frac{1}{2 + \sqrt{3}} \times \frac{2 - \sqrt{3}}{2 - \sqrt{3}}$$

Numerator:

$$= 2 - \sqrt{3}$$

Denominator:

$$(2+\sqrt{3})(2-\sqrt{3})$$

Use:

$$(a+b)(a-b)=a^2-b^2$$

$$=4-3$$

$$=1$$

Final Answer:

$$2-\sqrt{3}$$

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9. Surd Laws

Product Law

$$\sqrt{a}\times\sqrt{b}=\sqrt{ab}$$

Example:

$$\sqrt{3}\times\sqrt{12}=\sqrt{36}=6$$

Quotient Law

$$\frac{\sqrt{a}}{\sqrt{b}}=\sqrt{\frac{a}{b}}$$

Example:

$$\frac{\sqrt{18}}{\sqrt{2}}=\sqrt{9}=3$$

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10. Common WASSCE Exam Traps

Trap 1

$$\sqrt{a+b}\neq\sqrt{a}+\sqrt{b}$$

Example:

$$\sqrt{9+16}\neq 3+4$$

$$\sqrt{25}=5$$

but

$$3+4=7$$

Wrong.

Trap 2

$$(a+b)^2 \neq a^2 + b^2$$

Correct identity:

$$(a+b)^2 = a^2 + 2ab + b^2$$

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11. WASSCE Worked Examples

Example 1

Simplify:

$$\sqrt{45}$$

Solution:

$$45 = 9 \times 5$$

$$\sqrt{45} = \sqrt{9} \times \sqrt{5}$$

$$= 3\sqrt{5}$$

Answer:

$$3\sqrt{5}$$

Example 2

Evaluate:

$$2\sqrt{3} + 5\sqrt{3} - \sqrt{3}$$

$$= (2 + 5 - 1)\sqrt{3}$$

$$= 6\sqrt{3}$$

Answer:

$$6\sqrt{3}$$

Example 3

Simplify:

$$\frac{4}{\sqrt{5}}$$

$$\frac{4}{\sqrt{5}} \times \frac{\sqrt{5}}{\sqrt{5}}$$

$$= \frac{4\sqrt{5}}{5}$$

Answer:

$$\frac{4\sqrt{5}}{5}$$

12. WAEC Examiner Tips

1. Always simplify surds fully.
2. Leave answers in surd form unless told otherwise.
3. Rationalize denominators.
4. Collect like surds carefully.
5. Check for perfect square factors first.
6. Memorize conjugates and identities.

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13. Quick Revision Summary

Operation	Rule
Simplify	Extract perfect square
Add/Subtract	Only like surds
Multiply	Multiply coefficients and roots
Divide	Rationalize denominator
Conjugate	Change sign between terms

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14. Practice Questions

Easy

1. Simplify $\sqrt{20}$
2. Simplify $\sqrt{27}$
3. Evaluate $2\sqrt{5} + 3\sqrt{5}$

Medium

4. Simplify $(\sqrt{3} + 2)(\sqrt{3} + 1)$
5. Rationalize:

$$\frac{5}{\sqrt{7}}$$

Hard

6. Simplify:

$$\frac{3}{2 + \sqrt{5}}$$

7. Evaluate:

$$(\sqrt{2} + \sqrt{3})^2$$

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Answers

1.

$$2\sqrt{5}$$

2.

$$3\sqrt{3}$$

3.

$$5\sqrt{5}$$

4.

$$5+3\sqrt{3}$$

5.

$$\frac{5\sqrt{7}}{7}$$

6.

$$3(\sqrt{5}-2)$$

7.

$$5+2\sqrt{6}$$

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