JUNIOR CYCLE MATHS · FREE REVISION SHEET

Surds

↗ Léim

Learning outcomes (2018 specification): N.1b, U.13. Play the game: **leim.ie/surd-simplify.html**

1. What is a surd?

A square root that never comes out exact: √2, √3, √5, √12 … √9 = 3 and √25 = 5 are **not** surds. Leave answers "in surd form" (exact): √2, not 1.41.

2. Spot the pattern

√4 × √9 = 2 × 3 = 6	√36 = 6
√4 × √25 = 2 × 5 = 10	√100 = 10
√9 + √16 = 3 + 4 = 7	√25 = 5 (not 7!)

√a × √b = √(ab), but **√a + √b ≠ √(a + b)**.

3. The rules

Multiply: √a × √b = √(ab)
√2 × √8 = √16 = 4

Divide: √a ÷ √b = √(a ÷ b)
√50 ÷ √2 = √25 = 5

Square: (√a)² = a
(√7)² = 7 · (3√2)² = 9 × 2 = 18

4. Simplifying

Find the **biggest square number** that goes in: 4, 9, 16, 25, 36, 49, 64 …

√72 = √(36 × 2) = √36 × √2 = **6√2**
√48 = √(16 × 3) = **4√3** (2√12 is not finished)
Backwards: 3√5 = √9 × √5 = **√45**

5. Adding and subtracting

Only **like surds** (same number under the root). Treat √2 like x: 3√2 + 5√2 = 8√2.

√8 + √18 = 2√2 + 3√2 = **5√2** (simplify first)
√50 − √8 = 5√2 − 2√2 = **3√2**
√2 + √3 **can't be simplified** (it is not √5)

Multiply numbers and roots separately: 2√3 × 5√2 = 10√6.

6. Higher Level: brackets

Expand like algebra. √3 × √3 = 3.

√3(4 + √3) = 4√3 + 3 = **3 + 4√3**
(5 + √2)(5 − √2) = 25 − 2 = **23** (middle terms cancel)
(1 + √2)² = 1 + √2 + √2 + 2 = **3 + 2√2**

Classic mistakes: not using the biggest square (2√12) · √2 + √8 = √10 · 3√5 × 2√5 = 6√5 (it's 6 × 5 = 30) · (√6)² = 36 (it's 6) · (1 + √2)² = 1 + 2 (forgot the middle).

Exam tip: show the square you used: √72 = √36 × √2 = 6√2. "In the form a√b" means b must have no square factor left.

PRACTICE · 32 QUESTIONS

Have a go

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A. Simplify

1. √8 _____
2. √12 _____
3. √18 _____
4. √20 _____
5. √27 _____
6. √45 _____
7. √50 _____
8. √75 _____

B. Simplify (bigger squares)

9. √32 _____
10. √48 _____
11. √72 _____
12. √98 _____

C. Write as one square root

13. 2√3 _____
14. 3√2 _____
15. 5√2 _____

D. Add and subtract (or write "can't be simplified")

16. 4√3 + 2√3 _____
17. 7√5 − 3√5 _____
18. √8 + √18 _____
19. √12 + √27 _____
20. √50 − √8 _____
21. √2 + √3 _____

E. Multiply and divide

22. √3 × √12 _____
23. √2 × √5 _____
24. 2√3 × 4√2 _____
25. $(3\sqrt{5})^2$ _____
26. √60 ÷ √5 _____
27. 6√10 ÷ 2√2 _____

F. Higher Level: expand and simplify

28. √2(3 + √2) _____
29. (4 + √3)(4 − √3) _____
30. $(2 + \sqrt{5})^2$ _____

G. Exam-style (show your work)

31. A right-angled triangle has shorter sides 3 cm and 6 cm. Find the longest side in the form a√b.

32. A rectangle is √8 cm long and √18 cm wide. (a) Find its area. (b) Find its perimeter in the form a√b.

CHECK YOUR WORK

Answers

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A	1. 2√2 · 2. 2√3 · 3. 3√2 · 4. 2√5 · 5. 3√3 · 6. 3√5 · 7. 5√2 · 8. 5√3
B	9. 4√2 · 10. 4√3 · 11. 6√2 · 12. 7√2 (16, 16, 36, 49 are the squares)
C	13. √12 · 14. √18 · 15. √50
D	16. 6√3 · 17. 4√5 · 18. 5√2 · 19. 5√3 · 20. 3√2 · 21. can't be simplified (not like surds)
E	22. 6 · 23. √10 · 24. 8√6 · 25. 45 · 26. 2√3 · 27. 3√5
F	28. 2 + 3√2 · 29. 13 · 30. 9 + 4√5
G	31. $c^2 = 9 + 36 = 45$, c = √9 × √5 = **3√5 cm** · 32. (a) √8 × √18 = √144 = **12 cm²** (b) 2√2 + 3√2 + 2√2 + 3√2 = **10√2 cm**

Worked examples

10. √48
Biggest square in 48: 16. √48 = √16 × √3 = 4√3. (4 × 12 gives 2√12, then 2 × 2√3 = 4√3: same answer, more work.)

18. √8 + √18
√8 = 2√2, √18 = 3√2. Now they are like surds: 2√2 + 3√2 = 5√2.

24. 2√3 × 4√2
Numbers: 2 × 4 = 8. Roots: √3 × √2 = √6. Answer 8√6.

30. $(2 + √5)^2$
$(2 + √5)(2 + √5) = 4 + 2√5 + 2√5 + 5 = 9 + 4√5$.

Got one wrong? Did you use the biggest square? Did you simplify before adding? Did you multiply the numbers in front separately? Then play **Surd Simplify** at leim.ie/surd-simplify.html: the "Go back over these" list at the end shows the rule for each mistake.

All questions written by Léim. Léim is independent and not connected with the State Examinations Commission or the NCCA.