MATHS FORENSICS
CASE FILE WORKSHEET · GCSE

MF-CF-NUM-INDICES
GCSE HIGHER · ABOUT 50 MINUTES

CASE FILE SERIES · NUMBER

INDICES

Powers follow rules, and the rules never change. Secure the three laws, extend to negative and fractional powers, then master equations where the unknown is in the power.

SECURING · GRADES 4–5 | EXTENDING · GRADES 6–7 | MASTERY · GRADES 8–9

Name _____ Class _____ Date _____

CASE BRIEFING

WHAT YOU NEED TO KNOW

When you **multiply** powers of the same base, add the indices. When you **divide**, subtract them. A **power of a power**: multiply them.

A **negative** index means one over: $a^{-n} = 1 \div a^{n}$. A **fractional** index means a root: $a^{1/n}$ is the nth root, and $a^{m/n}$ is the nth root, raised to the power m. Anything to the power 0 is 1.

1. Deal with numbers and letters separately.
2. Apply one law at a time, writing each step.
3. For a fractional index, take the root first: the numbers stay small.
4. For an index equation, write both sides as powers of the same base, then set the indices equal.

WORKED EXAMPLE Evaluate $64^{-2/3}$.

SOLUTION

1 The negative means one over: $64^{-2/3} = 1 \div 64^{2/3}$.

2 The denominator 3 means cube root: $\sqrt[3]{64} = 4$.

3 The numerator 2 means square it: $4^2 = 16$.

4 So the answer is $1 \div 16$.

✓ **1/16**

KNOWLEDGE CHECK

Use your investigative skills to solve each case. Show full working: the method marks are where most students lose out.

Securing
The three laws: multiply, divide, power of a power.
Secured ☐

Extending
Zero, negative and fractional indices, brackets, and tampered evidence.
Secured ☐

Mastery
Unknowns in the power, and writing everything with one base.
Secured ☐

SECURING

The method, step by step. Show every line.

1 Simplify $a^5 \times a^3$. [1]

Answer _____

2 Simplify $y^9 \div y^4$. [1]

Answer _____

3 Simplify $(x^3)^4$. [1]

Answer _____

4 Simplify $3a^4 \times 5a^2$. [2]

Answer _____

FORENSIC TIP Numbers multiply, indices add. 3 × 5 = 15, not 8.

5 Write $2^3 \times 2^4 \div 2^2$ as a single power of 2, then work out its value. [2]

Answer _____

EXTENDING

A step is hidden, or there's a context to unpick. One piece of tampered evidence.

6 Evaluate $64^{2/3}$. [2]

Answer _____

7 Write as fractions: (a) 5^{-2} (b) $\left(\frac{2}{3}\right)^{-1}$ [2]

(a) ___ (b) _____

8 Simplify $(2x^3y)^4$. [2]

Answer _____

FORENSIC TIP The 2 is raised to the power 4 as well: $2^4 = 16$, not 8.

9 Simplify $\frac{12a^7b^3}{4a^2b^5}$. [2]

Answer _____

10 Sara simplified $(3x^2)^3$. Find her mistake and give the correct answer. [2]

TAMPERED EVIDENCE · FIND THE MISTAKE

$(3x^2)^3 = 3x^6$

Answer _____

MASTERY

No hints. Plan before you calculate.

11 Solve $2^{x+3} = 32$. [2]

x = _____

12 Solve $9^x = 27^{x-1}$. [3]

$x =$ _____

FORENSIC TIP Write both sides as powers of the **same base**. 9 and 27 are both powers of 3.

13 Evaluate $\left(\frac{27}{8}\right)^{-2/3}$. Give your answer as a fraction. [3]

Answer _____

14 $2^a = 8^x \times 4^{2x+1}$. Find a in terms of x. [3]

$a =$ _____

15 Show that $16^{3/4} \times 2^{-1} = 4$. [2]

KNOWLEDGE CHECK: SOLUTIONS

Check your method as well as your answer. In the exam, an answer with no working usually earns the final mark at most.

Q1 SECURING

✓ a^8

Q2 SECURING

✓ y^5

Q3 SECURING

✓ x^{12}

Q4 SECURING

Multiply the numbers, add the indices.

✓ $15a^6$

Q5 SECURING

3 + 4 − 2 = 5.

✓ $2^5 = 32$

Q6 EXTENDING

$\sqrt[3]{64} = 4$, then $4^2 = 16$.

✓ **16**

Q7 EXTENDING

A negative index flips the fraction.

✓ **(a) 1/25 (b) 3/2**

Q8 EXTENDING

Every factor inside is raised to the power 4.

✓ $16x^{12}y^4$

Q9 EXTENDING

12 ÷ 4, then subtract indices.

✓ $3a^5b^{-2}$, or $3a^5 \div b^2$

Q10 EXTENDING

She didn't cube the 3: $3^3 = 27$.

✓ $27x^6$

Mastery solutions are in the Lab. Grades 8 and 9 are won on method, so a bare answer won't tell you much. Photograph or write your Mastery working in **Forensic Marking** and get it marked mark by mark, with the full solution and the mistake behind every lost mark. Your first marked question is free.

lab.mathsforensics.com/written/?sheet=CF-NUM-INDICES

Mark your evidence

Level	Marks	My score	Secured? (every mark)
Securing	7		☐
Extending	10		☐
Mastery	13		☐

R · Reading
Misread or missed part of the question

M · Method
Didn't know how to do it

A · Accuracy
Knew how, slipped in the working

Write R, M or A next to every mark you lost. Mostly R or A? The fix is technique, not more practice of the topic.

CASE CLOSED: INDICES

In this case file you've learned to:

- Multiply, divide and raise powers using the three laws.
- Work with zero and negative indices.
- Evaluate fractional indices by taking the root first.
- Simplify expressions with numbers, letters and brackets.
- Solve equations by writing both sides with the same base.

Because every case comes down to one principle: numbers don't lie.

YOUR NEXT ASSIGNMENT

Practise every GCSE topic in the Lab

New numbers every time, feedback that names the mistake behind each wrong answer, and handwritten working marked like an examiner. Start free.

https://www.mathsforensics.com/the-lab