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GCSE MATHEMATICS • NUMBER

Indices

Worked Solutions

Pearson Edexcel GCSE (1MA1) & International GCSE (4MA1) • No calculator

Full worked solutions for the free Indices worksheet, GCSE and iGCSE Maths



Tap a section to jump straight to it

Full worked solutions for every question on the Indices worksheet, in the same order and with the same question numbers.

How to mark your work. Tick each step you got right, not just the final answer. In the exam, method marks are given for correct working even when the final answer is wrong. If you lost marks, find the *first* line where your working is different from ours. That is the thing to fix.

In Section E: **M** = method mark, **P** = process mark, **A** = accuracy mark, **B** = independent mark, **C** = communication mark.

Question sheet

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A**Your turn answers**

Compare each line of your working with the solution.

FOUNDATION

A1 (a) $3^{5+6} = 3^{11}$ (b) $2^{10-3} = 2^7$

A2 Top: $2^{4 \times 3} = 2^{12}$ Bottom: $2^{5+4} = 2^9$ $2^{12-9} = 2^3 = 8$

A3 (a) 1 (b) $\frac{1}{5^2} = \frac{1}{25}$ (c) $\left(\frac{4}{3}\right)^2 = \frac{16}{9}$

A4 (a) $5 \times 2 = 10$ and $b^{3+4} = b^7$ $10b^7$ (b) $3^3 = 27$ and $y^{2 \times 3} = y^6$ $27y^6$

HIGHER

A5 $\sqrt[3]{125} = 5$ $5^2 = 25$

A6 Flip: $\left(\frac{81}{16}\right)^{\frac{3}{4}}$ Fourth root top and bottom: $\frac{3}{2}$ Cube: $\frac{27}{8}$

A7 $8 = 2^3$ and $32 = 2^5$ $2^{3x} = 2^5$ $3x = 5$ $x = \frac{5}{3}$

A8 (a) $5^{q-1} = 5^q \div 5^1 = \frac{y}{5}$ (b) $25^q = (5^2)^q = (5^q)^2 = y^2$

B**Fluency solutions**One mark for each correct part unless stated. The notes in *italics* explain why each sequence was chosen.**FOUNDATION**

B1 (a) 16 (b) 16 (c) 16 (d) -16

2^4 and 4^2 happen to be equal, but a^b and b^a are usually different. In (d) there is no bracket, so only the 2 is raised to the power.



B2 (a) 3^7 (b) $3^{2+1} = 3^3$ (c) $3^{2-5} = 3^{-3}$ (d) $4^2 = 2^4$, so $2^4 \times 2^3 = 2^7$

The laws only work when the bases match. In (d) you must rewrite 4 as 2^2 first.

B3 (a) 7^6 (b) 7^{-6} (c) 7^0 , which is 1 (d) $7^{3-(-2)} = 7^5$

B4 (a) 5^6 (b) 5^6 (c) 5^{-4} (d) $5^0 = 1$

B5 (a) 1 (b) $\frac{1}{4}$ (c) $\frac{1}{1000}$ (d) $2^3 = 8$

B6 (a) a^7 (b) $3m^3$ (c) p^6q^3 (d) $12x^3$

HIGHER

B7 (a) $\sqrt{49} = 7$ (b) $\sqrt[3]{1000} = 10$ (c) $\sqrt[4]{81} = 3$ (d) $\frac{1}{6}$

B8 (a) $3^3 = 27$ (b) $\sqrt[5]{32} = 2$, $2^2 = 4$ (c) $10^3 = 1000$ (d) $2^4 = 16$

B9 (a) $\frac{1}{5}$ (b) $\frac{1}{3}$ (c) $\frac{1}{4^3} = \frac{1}{64}$ (d) $\left(\frac{9}{4}\right)^{\frac{1}{2}} = \frac{3}{2}$

B10 (a) $x = 5$ (b) $x = -2$ (c) $x = \frac{1}{2}$ (d) $2^{2x} = 2^{-3}$, so $x = -\frac{3}{2}$

B11 (a) $4x^2$ (b) $27^{\frac{2}{3}} = 9$ and $y^{6 \times \frac{2}{3}} = y^4$: $9y^4$ (c) x^2 (d) $x^{\frac{3}{2} - \frac{1}{2}} = x$

C

Reasoning solutions

Your wording can be different. Check that your reason makes the same point.

FOUNDATION

C1 She multiplied 2 by 3. 2^3 means $2 \times 2 \times 2 = 8$

C2 Using the division law, $5^3 \div 5^3 = 5^{3-3} = 5^0$. But any number divided by itself is 1. So $5^0 = 1$.



C3 $3^2 \times 3^3 = 3^5 = 243$ $9^5 = 59049$ **No.** You add the indices but the base stays as 3.

C4 $2^{-3} = \frac{1}{8}$ $3^{-2} = \frac{1}{9}$ $\frac{1}{8} > \frac{1}{9}$ **2^{-3} is greater**

C5 (a) $8 = 2^3$ and $4^2 = (2^2)^2 = 2^4$ $2^3 \times 2^4 = 2^7$ (b) $16 = 2^4$, so $\frac{1}{16} = 2^{-4}$

HIGHER

C6 He multiplied by the index. The 2 means square root and the 3 means cube: $\sqrt{16} = 4$, then $4^3 = 64$

C7 $4^{\frac{1}{2}} = 2$ $4^{-1} = \frac{1}{4}$ $4^0 = 1$ $4^{-\frac{1}{2}} = \frac{1}{2}$ $4^{\frac{3}{2}} = 8$

4^{-1} , $4^{-\frac{1}{2}}$, 4^0 , $4^{\frac{1}{2}}$, $4^{\frac{3}{2}}$

C8 $5^{-n} = \frac{1}{5^n} = 0.4$, so $5^n = \frac{1}{0.4} = 2.5$ $(5^n)^2 = 2.5^2 = 6.25$

C9 $\sqrt[3]{5} = 5^{\frac{1}{3}}$ and $25 = 5^2$ $5^{\frac{1}{3}} \times 5^2 = 5^{\frac{1}{3}+2} = 5^{\frac{7}{3}}$ **$n = \frac{7}{3}$**

C10 (a) $2^{n+1} = 2 \times 2^n$, so $2^{n+1} + 2^n = 2 \times 2^n + 2^n = 3 \times 2^n$ **as required**

(b) $2^{12} = 2^2 \times 2^{10}$, so $2^{12} + 2^{10} = 4 \times 2^{10} + 2^{10} = 5 \times 2^{10}$ **$2^{10} \times 5$**

D

Problem solving solutions

There is often more than one correct method. Any complete, correct method scores full marks.

FOUNDATION

D1 (a) **$2^6 = 64$** (b) $2^9 = 512$ and $2^{10} = 1024$ **10 hours**

D2 (a) $3^4 \times 3^4 = 3^8 \text{ cm}^2$ (b) $2^5 \times 2^3 = 2^8 = 256 \text{ cm}^2$

D3 $8 = 2^3$ $2^3 \times 2^{10} \times 2^{10} = 2^{23} \text{ bytes}$



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D4 (a) $x + 4 = 10$ $x = 6$ (b) $3x = 12$ $x = 4$ (c) $7 - x = -2$ $x = 9$

D5 Top: $6^{2-5} = 6^{-3}$ $6^{-3} \div 6^{-1} = 6^{-3+1} = 6^{-2} = \frac{1}{36}$

HIGHER

D6 Side = $\sqrt{2^7} = 2^{\frac{7}{2}} = 2^3 \times 2^{\frac{1}{2}} = 8\sqrt{2} \text{ cm}$

D7 (a) $7^m \times 7^n = ab$ (b) $(7^2)^m = (7^m)^2 = a^2$ (c) $7^n \div 7 = \frac{b}{7}$ (d) $(7^m)^2 \div 7^n = \frac{a^2}{b}$

D8 $2^x \times 2^{2y} = 2^5$ gives $x + 2y = 5$ $3^{x-y} = 3^2$ gives $x - y = 2$
Subtract: $3y = 3$, so $y = 1$ and $x = 3$ $x = 3, y = 1$

D9 $(3^2)^{x+1} = (3^3)^x$ $3^{2x+2} = 3^{3x}$ $2x + 2 = 3x$ $x = 2$

D10 (a) $2^x \times 2^3 = 5 \times 8 = 40$ (b) $(2^x)^2 = 5^2 = 25$ (c) $(2^x)^{-3} = 5^{-3} = \frac{1}{125}$

E

Exam practice solutions

Marks are shown on the right of each line.

FOUNDATION

Foundation and Higher crossover

E1	(a)	81	B1
	(b)	5 ⁸	B1
	(c)	9 ⁴	B1
	(d)	2 ¹⁵	B1



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- E2** (a) 1 B1
- (b) $\frac{1}{16}$ B1
- (c) $3^{4+5-7} = 3^2$ M1
- 9 A1

- E3** (a) m^9 B1
- (b) $4k^6$ B1 for 4, B1 for k^6
- (c) $16w^{12}$ B1 for 16, B1 for w^{12}

HIGHER

- E4** (a) 11 B1
- (b) $\sqrt[3]{216} = 6, 6^2 = 36$ M1
- $\frac{1}{36}$ A1
- (c) $\left(\frac{2}{3}\right)^4$ M1
- $\frac{16}{81}$ A1

- E5** (a) $81 = 3^4$ $n = -4$ B1
- (b) $3^{2n} = 3^5$ M1
- $n = \frac{5}{2}$ A1

- E6** Top: $25a^6b^4$ M1
- $a^{6-(-2)} = a^8$ and $b^{4-1} = b^3$ M1
- $25a^8b^3$ A1

- E7** $4^{x+2} = 2^{2x+4}$ M1
- $3x - 1 = 2x + 4$ M1
- $x = 5$ A1



E8	Top: $2^{n+2} + 2^n = 4 \times 2^n + 2^n = 5 \times 2^n$	M1 M1
	Bottom: $2^{n+1} - 2^n = 2 \times 2^n - 2^n = 2^n$	M1
	$\frac{5 \times 2^n}{2^n} = 5$ as required	A1

