

Laws of Indices in Algebra

Solutions

For Pearson Edexcel GCSE Mathematics (1MA1) • Foundation tier

Each question is shown in grey, followed by the working, one step per line. The final answer is in a box. *Marks* shows how the marks are usually given in the exam, and **Tip** points out a common mistake.

1 (3 marks)

(a) Simplify $n^5 \times n^4$

When you multiply, add the powers.

$$5 + 4 = 9$$

Answer: n^9

Tip: Multiplying means *add* the powers. $n^5 \times n^4 = n^9$, not n^{20} .

(b) Simplify $y^{12} \div y^3$

When you divide, subtract the powers.

$$12 - 3 = 9$$

Answer: y^9

(c) Simplify $(e^4)^3$

This is a power of a power, so multiply the powers.

$$4 \times 3 = 12$$

Answer: e^{12}

2 (2 marks)

- (a) Simplify $t \times t \times t$

Three t 's are multiplied together.

So the power is 3.

Answer: t^3

- (b) Simplify $p^3 + p^3$

This is *adding*, not multiplying.

One p^3 plus another p^3 is two lots of p^3 .

The power does not change.

Answer: $2p^3$

Tip: The index laws are only for multiplying and dividing. When you add like terms, the power stays the same: $2p^3$, not p^6 .

3 (3 marks)

- (a) Simplify $(p^2)^5$

Power of a power, so multiply the powers.

$$2 \times 5 = 10$$

Answer: p^{10}

Tip: For a power of a power, *multiply*: $(p^2)^5 = p^{10}$. Adding gives the wrong answer p^7 .

- (b) Simplify $15x^6y^4 \div 3x^2y$

Divide the numbers: $15 \div 3 = 5$

Subtract the x powers: $x^{6-2} = x^4$

Subtract the y powers: $y^{4-1} = y^3$ (the y on its own is y^1)

Answer: $5x^4y^3$

Tip: Divide the numbers in front ($15 \div 3 = 5$). Do not subtract them ($15 - 3 = 12$).

Marks: 2 marks for $5x^4y^3$. 1 mark for two of 5, x^4 and y^3 .

4 (2 marks)

Simplify $4a^3b^2 \times 6ab^5$

Multiply the numbers: $4 \times 6 = 24$

Add the a powers: $a^{3+1} = a^4$ (the a on its own is a^1)

Add the b powers: $b^{2+5} = b^7$

Answer: $24a^4b^7$

Tip: Multiply the numbers ($4 \times 6 = 24$) but add the powers. A letter with no power shown has power 1.

Marks: 2 marks for $24a^4b^7$. 1 mark for two of 24, a^4 and b^7 .

5 (2 marks)

Simplify $(2mp^4)^3$

Everything inside the bracket is cubed.

Cube the number: $2^3 = 8$

Cube m : m^3

Cube p^4 : $(p^4)^3 = p^{12}$

Answer: $8m^3p^{12}$

Tip: The number is cubed too: $2^3 = 8$, not 2 or 6.

Marks: 2 marks for $8m^3p^{12}$. 1 mark for two of 8, m^3 and p^{12} .

6 (2 marks)

(a) $x^7 \times x^n = x^{12}$

Work out the value of n .

Multiplying, so add the powers:

$$7 + n = 12$$

$$n = 12 - 7 = 5$$

Answer: $n = 5$

(b) $(x^3)^n = x^{21}$

Work out the value of n .

Power of a power, so multiply the powers:

$$3n = 21$$

$$n = 21 \div 3 = 7$$

Answer: $n = 7$

7 (2 marks)

(a) Simplify $y^{-3} \times y^7$

Multiplying, so add the powers:

$$-3 + 7 = 4$$

Answer: y^4

(b) Simplify $(k^4)^{-2}$

Power of a power, so multiply the powers:

$$4 \times (-2) = -8$$

Answer: k^{-8} (or $\frac{1}{k^8}$)

8 (2 marks)

Simplify $\frac{x^5 \times x^3}{x^4}$

Simplify the top first: $x^5 \times x^3 = x^{5+3} = x^8$

Then divide: $x^8 \div x^4 = x^{8-4} = x^4$

Answer: x^4

Marks: 1 mark for x^8 . 1 mark for x^4 .

9 (1 mark)

Sam says,

$$'3^2 \times 3^4 = 9^6'$$

Explain why Sam is wrong.

$3^2 \times 3^4$ means $(3 \times 3) \times (3 \times 3 \times 3 \times 3)$.

That is six 3's multiplied together, so it is 3^6 .

When you multiply, the base stays the same and you add the powers.

Sam has wrongly multiplied the bases ($3 \times 3 = 9$).

Answer: The base should stay as 3: $3^2 \times 3^4 = 3^6$

10 (2 marks)

Simplify $(3a^2b)^2$

Everything inside the bracket is squared.

Square the number: $3^2 = 9$

Square a^2 : $(a^2)^2 = a^4$

Square b : b^2

Answer: $9a^4b^2$

Marks: 2 marks for $9a^4b^2$. 1 mark for two of 9, a^4 and b^2 .

11 (2 marks)

(a) Write down the value of x^0

Any number (except 0) to the power 0 is 1.

Answer: 1

(b) Simplify $8y^0$

Only the y has the power 0, so $y^0 = 1$.

$$8y^0 = 8 \times 1 = 8$$

Answer: 8

Tip: The power 0 only belongs to the y , not the 8. So the answer is 8, not 1.

12 (2 marks)

A rectangle has length $4x^3$ cm and width $2x^2$ cm.

Find an expression for the area of the rectangle.

Give your answer in its simplest form.

Area = length $\times$ width

$$\text{Area} = 4x^3 \times 2x^2$$

Multiply the numbers: $4 \times 2 = 8$

Add the powers: $x^{3+2} = x^5$

Answer: $8x^5 \text{ cm}^2$

Marks: 1 mark for $4x^3 \times 2x^2$. 1 mark for $8x^5$.

13 (2 marks)

Show that $(2x^3)^2 \times x = 4x^7$

$$(2x^3)^2 = 2^2 \times x^{3 \times 2} = 4x^6$$

x on its own is x^1 .

$$4x^6 \times x^1 = 4x^{6+1} = 4x^7$$

Marks: 1 mark for $4x^6$. 1 mark for completing the working to reach $4x^7$.

14 (3 marks)

(a) Simplify fully $3x^4y^2 \times 5xy^6$

Multiply the numbers: $3 \times 5 = 15$

Add the x powers: $x^{4+1} = x^5$

Add the y powers: $y^{2+6} = y^8$

Answer: $15x^5y^8$

Marks: 2 marks for $15x^5y^8$. 1 mark for two of 15, x^5 and y^8 multiplied together.

(b) Simplify $(p^{-2})^{-4}$

Power of a power, so multiply the powers.

$$-2 \times (-4) = +8 \text{ (negative} \times \text{negative} = \text{positive)}$$

Answer: p^8

Tip: Multiply the powers, and take care with the signs: $-2 \times (-4) = +8$. Common wrong answers are p^{-6} and p^{-8} .
