

Laws of Indices in Algebra

Solutions

For AQA GCSE Mathematics (8300) • 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 (4 marks)

Simplify fully

(a) $y \times y \times y \times y$

Four y 's are multiplied together.

So the power is 4.

Answer: y^4

(b) $a^3 \times a^4$

When you multiply, add the powers.

$$3 + 4 = 7$$

Answer: a^7

Tip: Multiplying means *add* the powers: $a^3 \times a^4 = a^7$, not a^{12} .

(c) $b^9 \div b^3$

When you divide, subtract the powers.

$$9 - 3 = 6$$

Answer: b^6

Tip: Dividing means *subtract* the powers: $9 - 3 = 6$. Do not divide them ($9 \div 3 = 3$).

(d) $(c^2)^5$

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

$$2 \times 5 = 10$$

Answer: c^{10}

Tip: For a power of a power, *multiply* the powers: $(c^2)^5 = c^{10}$, not c^7 .

2 (1 mark)

Circle the expression that is equal to m^8

Options: $m^2 \times m^4$, $(m^4)^2$, $m^{16} \div m^2$, $m^4 + m^4$

$$m^2 \times m^4 = m^{2+4} = m^6$$

$$(m^4)^2 = m^{4 \times 2} = m^8 \quad \checkmark$$

$$m^{16} \div m^2 = m^{16-2} = m^{14}$$

$$m^4 + m^4 = 2m^4 \text{ (adding like terms does not change the power)}$$

Answer: $(m^4)^2$

Tip: $m^4 + m^4$ is an addition, not a multiplication. It simplifies to $2m^4$, not m^8 .

3 (2 marks)

Simplify fully $4m^3 \times 2m^5$

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

Add the powers: $m^3 \times m^5 = m^{3+5} = m^8$

Answer: $8m^8$

Tip: The numbers in front are multiplied ($4 \times 2 = 8$), not added. Only the powers are added.

Marks: 2 marks for $8m^8$. 1 mark if only one part is right: the 8 or the m^8 .

4 (3 marks)

Ruari simplifies $20x^{10} \div 5x^2$

Here is his working.

$$20 \div 5 = 4$$

$$10 \div 2 = 5$$

$$\text{Answer } 4x^5$$

- (a) Ruari's answer is wrong.
Describe the mistake he has made.

$20 \div 5 = 4$ is correct: the numbers in front are divided.

But for the powers, Ruari divided 10 by 2.

When you divide powers of x , you should *subtract* the powers: $10 - 2$.

Answer: He divided the powers ($10 \div 2$) when he should have subtracted them ($10 - 2$).

- (b) Simplify $20x^{10} \div 5x^2$ correctly.

Divide the numbers: $20 \div 5 = 4$

Subtract the powers: $x^{10-2} = x^8$

Answer: $4x^8$

Tip: Divide the numbers in front, but subtract the powers. Do not divide the powers.

Marks: 2 marks for $4x^8$. 1 mark if only one part is right: the 4 or the x^8 .

5 (2 marks)

Simplify fully $12x^7 \div 4x^3$

Divide the numbers: $12 \div 4 = 3$

Subtract the powers: $x^{7-3} = x^4$

Answer: $3x^4$

Marks: 2 marks for $3x^4$. 1 mark if only one part is right: the 3 or the x^4 .

6 (2 marks)

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

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

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

Add the powers: $a^{3+3} = a^6$

Answer: $4a^6$

Tip: The bracket is squared, so the 2 is squared too: $2^2 = 4$. A common wrong answer is $2a^6$.

Marks: 2 marks for $4a^6$. 1 mark if only one part is right: the 4 or the a^6 .

7 (3 marks)

Work out the value of n in each of these.

(a) $m^4 \times m^n = m^{11}$

Multiplying, so add the powers:

$$4 + n = 11$$

$$n = 11 - 4 = 7$$

Answer: $n = 7$

(b) $(k^3)^n = k^{15}$

Power of a power, so multiply the powers:

$$3 \times n = 15$$

$$n = 15 \div 3 = 5$$

Answer: $n = 5$

(c) $p^{10} \div p^n = p^6$

Dividing, so subtract the powers:

$$10 - n = 6$$

$$n = 10 - 6 = 4$$

Answer: $n = 4$

8 (2 marks)

(a) Write down the value of y^0

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

Answer: 1

(b) Simplify $a^5 \div a^5$

Subtract the powers: $a^{5-5} = a^0 = 1$

This makes sense: anything divided by itself is 1.

Answer: 1

Tip: The answer is 1, not 0 and not a .

9 (2 marks)

Simplify fully $2a^2b \times 3ab^4$

Multiply the numbers: $2 \times 3 = 6$

a on its own means a^1 , so $a^2 \times a^1 = a^{2+1} = a^3$

b on its own means b^1 , so $b^1 \times b^4 = b^{1+4} = b^5$

Answer: $6a^3b^5$

Tip: A letter with no power shown has a power of 1. Don't forget to count it.

Marks: 2 marks for $6a^3b^5$. 1 mark for two of 6, a^3 and b^5 .

10 (2 marks)

Tick **one** box for each statement.

	True	False
$x^2 \times x^3 = x^6$		✓
$(x^2)^3 = x^6$	✓	
$x^8 \div x^4 = x^2$		✓
$x \times x^4 = x^5$	✓	

$x^2 \times x^3 = x^{2+3} = x^5$, not x^6 (add the powers, don't multiply).
 $(x^2)^3 = x^{2 \times 3} = x^6$ ✓
 $x^8 \div x^4 = x^{8-4} = x^4$, not x^2 (subtract the powers, don't divide).
 $x \times x^4 = x^{1+4} = x^5$ ✓ (remember $x = x^1$)

Marks: 2 marks for all four correct. 1 mark for two or three correct.

11 (2 marks)

Simplify fully $\frac{a^4 \times a^6}{a^5}$

Simplify the top first: $a^4 \times a^6 = a^{4+6} = a^{10}$

Then divide: $a^{10} \div a^5 = a^{10-5} = a^5$

Answer: a^5

Marks: 1 mark for a^{10} . 1 mark for a^5 .

12 (2 marks)

A square has sides of length $3x^2$ cm.

Work out an expression for the area of the square.

Give your answer in its simplest form.

Area of a square = side $\times$ side

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

Multiply the numbers: $3 \times 3 = 9$

Add the powers: $x^{2+2} = x^4$

Answer: $9x^4 \text{ cm}^2$

Marks: 1 mark for $3x^2 \times 3x^2$. 1 mark for $9x^4$.

13 (2 marks)

Simplify fully $\frac{10x^5y^3}{2x^2y}$

Divide the numbers: $10 \div 2 = 5$

Subtract the x powers: $x^{5-2} = x^3$

Subtract the y powers: $y^{3-1} = y^2$ (the y on the bottom is y^1)

Answer: $5x^3y^2$

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

14 (2 marks)

Here is an identity.

$$(ax^5)^3 \equiv 64x^b$$

a and b are whole numbers.

Work out the values of a and b .

Expand the bracket: $(ax^5)^3 = a^3 \times (x^5)^3 = a^3x^{15}$

Compare the numbers: $a^3 = 64$

$4 \times 4 \times 4 = 64$, so $a = 4$

Compare the powers: $x^{15} = x^b$, so $b = 15$

Answer: $a = 4$, $b = 15$

Tip: The cube applies to the number as well as the letter, so $a^3 = 64$, not $3a = 64$. For the power, multiply: $5 \times 3 = 15$ (not $5 + 3 = 8$).

Marks: 1 mark for $a = 4$. 1 mark for $b = 15$.
