GCSE Maths – Algebra

Laws of Indices

Worksheet

NOTES

SOLUTIONS

This worksheet will show you how to work out different types of questions involving indices. Each section contains a worked example, a question with hints and then questions for you to work through on your own.

Section A

Worked Example

Simplify $2a^5 \times 6b^2 \times 3a^7$

Step 1: Write out the expression by separating any constants that are present and grouping these together. Then group any variables that are present together, (grouping the same letters together).

$$2a^5 \times 6b^2 \times 3a^7 = 2 \times 3 \times 6 \times a^5 \times a^7 \times b^2$$

Step 2: Multiply together any constants that are present.

$$2a^5 \times 6b^2 \times 3a^7 = 2 \times 3 \times 6 \times a^5 \times a^7 \times b^2 = 36 \times a^5 \times a^7 \times b^2$$

Step 3: Multiply any terms with powers together - if they have the same base, add the powers.

In this example we add the powers of 'a' as they have the same base:

$$a^5 \times a^7 = a^{(5+7)} = a^{12}$$

$$36 \times a^5 \times a^7 \times b^2 = 36a^{(5+7)} \times b^2 = 36a^{12} \times b^2 = 36a^{12}b^2$$

Answer: $36a^{12}b^2$

Guided Example

Simplify $12c^3 \times 3c^7 \times 5d^2$

Step 1: Write out the expression by separating any numbers that are present and grouping these together. Then group any variables that are present together, (grouping the same letters together).

Step 2: Multiply together any constants that are present.

Step 3: Multiply any terms with powers together - if they have the same base, add the powers

1. Simplify the following:

a) $8p^4 \times 4p^8$

b) $7r^6 \times 8s^5 \times 9r^4$

c) $2^5 \times 2^8 \times a^3$

d) $9f^4 \times 4^8 \times 2g^8 \times 4^5$

e) $5^5 \times e^4 \times 4 \times 5^5 \times 5e^3$

Section B

Worked Example

Simplify $8a^8b^4 \div 4a^3b$

Step 1: The expression can be written as a fraction. This might help you to visualise the common terms.

$$8a^8b^4 \div 4a^3b = \frac{8a^8b^4}{4a^3b}$$

Step 2: Divide any common constants to simplify the fraction.

$$8a^8b^4 \div 4a^3b = \frac{8a^8b^4}{4a^3b} = \frac{2a^8b^4}{a^3b}$$

In this example, dividing the top and bottom of the fraction by 4 gives a more simplified fraction.

Step 3: Divide any common terms which have powers - if they have the same base, subtract the powers.

In this example we subtract the powers of $'a'$ and $'b'$ as they have the same base:

$$a^8 \div a^3 = a^{(8-3)} = a^5$$
$$b^4 \div b^1 = b^3$$

$$\frac{2a^8b^4}{a^3b^1} = 2a^{(8-3)}b^{(4-1)} = 2a^5b^3$$

Answer: $\mathbf{2a^5b^3}$

Guided Example

Simplify: $9c^5d^2 \div 3cd$

Step 1: Sometimes the expression can be written as a fraction with a numerator and a denominator. This might help you to visualise the common terms.

Step 2: Divide any common constants to simplify the fraction.

Step 3: Divide any common terms which have powers - if they have the same base, subtract the powers.

2. Simplify the following:

a) $x^2y^3 \div xy^2$

b) $16f^7g^2 \div 4f^3g$

c) $2r^8s^5t^2 \div r^2s^2$

d) $21j^8k^3l^3 \div 3k^2l$

e) $45x^9y^{10}z^5 \div 5x^{12}y^7$

Worked Example

Simplify $(8^2 a^7)^5$

Step 1: When raising one power to another, multiply the powers together. If there is a complicated term within the bracket, separate the components and deal with them individually.

$$(8^2 a^7)^5 = (8^2)^5 \times (a^7)^5$$

$$(8^2)^5 = 8^{2 \times 5} = 8^{10}$$
$$(a^7)^5 = a^{7 \times 5} = a^{35}$$

$$(8a^7)^5 = 8^{10} a^{35}$$

Step 2: Calculate the value of any constant that is raised to a numerical power.

$$(8a^7)^5 = 8^{10} a^{35} = 8^{10} \times a^{35} = 1073741824 a^{35}$$

In this example it is probably best to expand the 8^{10} using a calculator.

For high powers, the number raised to a power can be left in base-index form.

Answer: $\mathbf{1073741284 a^{35}}$ *or* $\mathbf{8^{10} a^{35}}$

Guided Example

Simplify $\left(17b^2\right)^3$

Step 1: When raising one power to another, multiply them together. If there is a complicated term within the bracket, separate the components and deal with them individually.

Step 2: Calculate the value of any constant that is raised to a numerical power.

Now it's your turn!
If you get stuck, look back at the worked and guided examples.

3. Simplify the following:

a) $(8^9)^3$

b) $(h^4)^{16}$

c) $(ft^8)^5$

d) $(c^2d^3)^4$

e) $(17^5z^9)^{16}$