Edward Peake Church of England Middle School

Topic: Indices	Year: 8	NC Strand: Algebra

What should I already know?

- I can use diagrams and letters to generalise number operations
- I can use diagrams and letters with single function machines
- I can find the function machine given a simple expression
- I can use diagrams and letters with a series of of two function machines

What will I know by the end of the unit?

- How to add and subtract expressions with indices
- How to simplify algebraic expressions by multiplying indices
- How to simplify algebraic expressions by dividing indices
- How to use the addition law for indices
- How to use the subtraction law for indices
- How to use the addition and subtraction laws for indices
- How to explore powers of powers

Key Information/Diagrams

Index notation

We use index notation to show repeated multiplication by the same number.

For example,

we can use index notation to write **2 × 2 × 2 × 2 × 2** as

Index or power

2^5

base

This number is read as 'two to the power of five'.

$2^5 = 2 \times 2 \times 2 \times 2 \times 2 = 32$

Index notation

Evaluate the following:

$6^2 = 6 \times 6 = 36$

$3^4 = 3 \times 3 \times 3 \times 3 = 81$

$(-5)^3 = -5 \times -5 \times -5 = -125$

$2^7 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 128$

$(-1)^5 = -1 \times -1 \times -1 \times -1 \times -1 = -1$

$(-4)^4 = -4 \times -4 \times -4 \times -4 = 64$

When we raise a negative number to an odd power the answer is negative.

When we raise a negative number to an even power the answer is positive.

The first index law

When we multiply two numbers written in index form and with the same base we can see an interesting result.

For example,

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

$7^3 \times 7^5 = (7 \times 7 \times 7) \times (7 \times 7 \times 7 \times 7 \times 7)$
$= 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7$
$= 7^8 = 7^{(3+5)}$

When we **multiply** two numbers with the **same base** the indices are **added**.

The second index law

When we divide two numbers written in index form and with the same base we can see another interesting result.

For example,

$$4^5 \div 4^2 = \frac{\cancel{4} \times \cancel{4} \times 4 \times 4 \times 4}{\cancel{4} \times \cancel{4}} = 4 \times 4 \times 4 = 4^3 = 4^{(5-2)}$$

$$5^6 \div 5^4 = \frac{\cancel{5} \times \cancel{5} \times \cancel{5} \times \cancel{5} \times 5 \times 5}{\cancel{5} \times \cancel{5} \times \cancel{5} \times \cancel{5}} = 5 \times 5 = 5^2 = 5^{(6-4)}$$

When we **divide** two numbers with the **same base** the indices are **subtracted**.

Zero indices

Look at the following division:

$6^4 \div 6^4 = 1$

Using the second index law

$6^4 \div 6^4 = 6^{(4-4)} = 6^0$

That means that

$6^0 = 1$

In fact, *any* number raised to the power of 0 is equal to 1.

For example,

$10^0 = 1$ $3.452^0 = 1$ $723\,538\,592^0 = 1$

Negative indices

Look at the following division:

$$3^2 \div 3^4 = \frac{\cancel{3} \times \cancel{3}}{\cancel{3} \times \cancel{3} \times 3 \times 3} = \frac{1}{3 \times 3} = \frac{1}{3^2}$$

Using the second index law

$3^2 \div 3^4 = 3^{(2-4)} = 3^{-2}$

That means that

$3^{-2} = \frac{1}{3^2}$

Similarly, $6^{-1} = \frac{1}{6}$ $7^{-4} = \frac{1}{7^4}$ and $5^{-3} = \frac{1}{5^3}$

Using algebra

We can write all of these results algebraically.

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

$$a^m \div a^n = a^{(m-n)}$$

$$a^0 = 1$$

$$a^{-1} = \frac{1}{a}$$

$$a^{-n} = \frac{1}{a^n}$$

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Key Questions

What is the difference between a term and an expression?

When are terms 'like terms'?

When can/can't an expression be simplified?

Why don't we usually write '$1x$' or '$0x$'?

What is the difference between a base and an index?
How can you simplify the multiplication of two terms involving indices if they have the same base?
Can you use the same rule if the bases are different?
Why is e.g. $a^6 \times a = a^7$ when there is no index on the second term?

What does the word 'index' mean?
What is the result of multiplying x^2 by x? And then multiplying by x again? And again?
What is your strategy for multiplying e.g. $3a^2b$ and $5ab^3$?
What do you look at first? Then what?

What is the difference between a base and an index?
How can you simplify the multiplication of two terms involving indices if they have the same base?
Can you use the same rule if the bases are different?
Why is (e.g.) $a^6 \div a = a^5$ when there is no index on the second term?

What is the difference between a term and an expression?

When can/can't an expression be simplified?

How would you start solving an index question that involves more than one operation?
Will $\left(a^b\right)^c$ be the same as, or different from $(a^c)^b$? Why?
Why do we need to be careful with expressions like $(5x^4)^3$?

Vocabulary

Expression	Term	Simplify	Simplify
Simplify	Power	Numerator	Base
Term	Multiply	Denominator	Power
Coefficient	Product	Factor	Exponent
Index	Power	Common factor	
Indices	Expand	Coefficient	

Investigate/Homework tasks

- Homework will be set by your teacher using google classroom
- You should complete at least 30 minutes of maths tasks using the website and log in provided by your teacher. Please attend help sessions if you do not have access to the internet at home
- Additional work you could complete:
    - Find out more about the meaning of the vocabulary list using http://www.amathsdictionaryforkids.com/
- To challenge yourself: Answer the key questions to deepen your knowledge