

# Year 9 Knowledge Organiser

## Indices

### What do I need to be able to do?

By the end of this unit you should be able to:

- Identify square and cube numbers
- Calculate higher powers and roots
- Understand powers of 10 and standard form
- Know the addition and subtraction rule for indices
- Understand power zero and negative indices
- Calculate with numbers in standard form

### Keywords

**Standard (index) Form:** A system of writing very big or very small numbers

**Commutative:** an operation is commutative if changing the order does not change the result

**Base:** The number that gets multiplied by a power

**Power:** The exponent – or the number that tells you how many times to use the number in multiplication

**Exponent:** The power – or the number that tells you how many times to use the number in multiplication

**Indices:** The power or the exponent

**Negative:** A value below zero.

**Coefficient:** The number used to multiply a variable

### Square and cube numbers

#### Square numbers

4, 9, 16...

$$144 = 2 \times 2 \times 2 \times 2 \times 3 \times 3$$

$$(2 \times 2 \times 3) \times (2 \times 2 \times 3)$$

Prime factors can find square roots

$$\sqrt{144} = 12$$

#### Cube numbers

8, 27, 64, 125...

$$216 = 2 \times 2 \times 2 \times 3 \times 3 \times 3$$

$$(2 \times 3) \times (2 \times 3) \times (2 \times 3)$$

$$6 \times 6 \times 6$$

$$\sqrt[3]{216} = 6$$

### Higher powers and roots

$x^n$  ←  $n$  – power (number of times multiplied by itself)  
 $x$  – the base number

$\sqrt[n]{x}$  ← Finding the  $n$ th root of any value

Other mental strategies for square roots

$$\begin{aligned}\sqrt{810000} &= \sqrt{81} \times \sqrt{10000} \\ &= 9 \times 100 \\ &= 900\end{aligned}$$

### Standard form

Any number between 1 and less than 10

$$A \times 10^n$$

Any integer

$$0.001$$

$$1 \times \frac{1}{1000}$$

$$1 \times 10^{-3}$$

|        |        |                |                 |                  |
|--------|--------|----------------|-----------------|------------------|
| 10     | 1      | $\frac{1}{10}$ | $\frac{1}{100}$ | $\frac{1}{1000}$ |
| $10^1$ | $10^0$ | $10^{-1}$      | $10^{-2}$       | $10^{-3}$        |
| 10     | 1      | 0.1            | 0.01            | 0.001            |

Any value to the power 0 always = 1

Numbers in standard form with negative powers will be less than 1

$$3.2 \times 10^{-4} = 3.2 \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = 0.00032$$

#### Example

$$3.2 \times 10^{-4}$$

$$= 3.2 \times 10 \times 10 \times 10 \times 10$$

$$= 32000$$

#### Non-example

$$0.8 \times 10^{-4}$$

$$5.3 \times 10^{0.7}$$

Negative powers do not indicate negative solutions

### Addition/ Subtraction Laws

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

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

### Zero and negative indices

$$x^0 = 1$$

$$\frac{a^6}{a^6} = a^6 \div a^6$$

$$= a^{6-6} = a^0 = 1$$

Negative indices do not indicate negative solutions

$$2^2 = 4$$

$$2^1 = 2$$

$$2^0 = 1$$

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

$$2^{-2} = \frac{1}{4}$$

Looking at the sequence can help to understand negative powers

### Powers of powers

$$(x^a)^b = x^{ab}$$

$$(2^3)^4 = 2^3 \times 2^3 \times 2^3 \times 2^3$$

The same base and power is repeated. Use the addition law for indices

$$(2^3)^4 = 2^{12} \leftarrow a \times b = 3 \times 4 = 12$$

NOTICE the difference

$$(2x^3)^4 = 2x^3 \times 2x^3 \times 2x^3 \times 2x^3$$

The addition law applies ONLY to the powers. The integers still need to be multiplied

$$(2x^3)^4 = 16x^{12}$$

### Standard form calculations

#### Addition and Subtraction

Tip: Convert into ordinary numbers first and back to standard form at the end

$$6 \times 10^5 + 8 \times 10^5$$

Method 1

$$= 600000 + 800000$$

$$= 1400000$$

$$= 1.4 \times 10^6$$

Multiplication and division

$$1.5 \times 10^5$$

$$0.3 \times 10^3$$

$$(1.5 \times 10^5) + (0.3 \times 10^3)$$

$$15 - 0.3 \times 10^5 - 10^3$$

$$= 5 \times 10^2$$

Method 2

$$= (6 + 8) \times 10^5$$

$$= 14 \times 10^5$$

$$= 1.4 \times 10^1 \times 10^5$$

$$= 1.4 \times 10^6$$

$$= 1.4 \times 10^6$$

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For multiplication and division you can look at the values for A and the powers of 10 as two separate calculations