MTH1W

**Math 9 – Unit 1: Real Numbers**

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**Lesson #5: Powers and Scientific Notations**

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**Learning Goal**: We are learning to work with powers and expressing numbers in scientific notation

Powers, as the name suggests, are a powerful way to express repeated multiplication of the same number. Specifically, powers of 10 express very large and very small numbers in a manner which is convenient to read, write and compare.

In science and engineering, quite often you want to represent very large or very small numbers. For example, the Mass of earth is 5,970,000,000,000, 000, 000, 000, 000 kg and the Size of a bacteria is 0.0000005 m. Is there a more convenient way to represent this without having to write a lot of zeros?
Yes! This can be achieved by using Scientific Notation. However, scientific notation utilizes powers, so we first need to discuss exponents.

A power is the number of times you multiply the base by itself.

A power has two parts. The base is the number used in the multiplication. An exponent indicates how many times the repeated multiplication occurs.

$4^3$ → exponent

→ base

A power can be written in two forms. Exponential form is the same as the above example, then there is the expanded (or standard) form which shows the repeated multiplication.

$4^3 = 4 \times 4 \times 4 = 64$

**Example 1:** Write the following in expanded form, then evaluate:

a) $5^4$

$= 5 \times 5 \times 5 \times 5$

$= 625$

b) $(-3)^2$

$= (-3) \times (-3)$

$= 9$

c) $-3^2$

"the negative of $3^2$"

$= -(3 \times 3)$

$= -9$

d) $\left(\frac{2}{3}\right)^3$

$= \left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right)$

$= \frac{8}{27}$

**Now for some interesting ones:**

e) $4^1$

$= 4$

f) $4^0$

$= 1$

Keep these in mind for next unit

$4^0 = 1$ ÷4

$4^1 = 4$ ÷4

$4^2 = 16$ ÷4

$4^3 = 64$

h) $4^{-1}$

$= \frac{1}{4}$

$4^0 = 1$ ÷4

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

i) $4^{-2}$

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

$= \frac{1}{16}$

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**Powers of 10**. Powers of 10 are quick to calculate and they are, well, powerful!

To evaluate a power of 10, the exponent indicates how many zeros will be behind the 1 or in front of the 1 if negative (with the decimal after the first zero).

$10^5 =$ 100000 (5 zeros/place values) $\qquad 10^{-5} =$ 0.00001 (5 zeros)

When writing really large (or really small) numbers, we can use scientific notation to eliminate the need to write all the zeros and focus on the significant digits.

**Scientific to ~~Expanded:~~ Standard:** Write the full number from the scientific notation:

a) $3.45 \times 10^6$ → 6 place values $\qquad$ b) $6.2 \times 10^{-7}$

= 3450000 (6 place values) $\qquad$ = 0.00000062

Earth is $1.496 \times 10^8$ km from the sun, or

= 149600000 km (8 place values)

An atom of Hydrogen is $1.674 \times 10^{-27}$ kg, or

0.000000000000000000000001674 kg

**Expanded to Scientific:** Convert the numbers to scientific notation. **Keep 3 digits** after.

a) 0.000000432 (7) $\qquad$ b) 82348709008713 (12 p.v.)

$4.32 \times 10^{-7}$ $\qquad$ = $8.235 \times 10^{13}$

Neptune is 4,497,000,000 km from the sun, or

= $4.497 \times 10^9$ km.

An atom of titanium is 0.00000000000000000000000795 kg, or

$7.95 \times 10^{-26}$ kg

**Success Criteria**:

- I recognize the two parts of a power
- I can express powers in the expanded form and vice-versa
- I can express very big and very small numbers using scientific notation