How big is the universe?

Learn to calculate with the power of 10.

If you were asked the simple question: “How many meters make a kilometer?” You would probably (hopefully) say “one thousand”.

Indeed. 1000 meters equals 1 kilometer. Scientists use a different notation for this. They use the power of 10. In other words: 1000 meters is 10 x 10 x 10 meters, or 103 meters.

In the metric system, something that equals one thousand times the standard value, is given the word ‘kilo’. Here are some examples:

|  |  |  |  |
| --- | --- | --- | --- |
| **Quantity** | **Kilo-** | **Abbreviation** | **Scientific notation** |
| 1000 grams | 1 kilogram | 1 kg | 1 x 103 grams |
| 1000 meters | 1 kilometer | 1 km | 1 x 103 meters |
| 1000 bytes | 1 kilobyte | 1 kb | 1 x 103 bytes |
| 1000 liters | 1 kiloliter | 1 kl | 1 x 103 liters |

You can even go bigger. For example: 1 million bytes equals 1000 x 1000 bytes. This is 1000 kilobytes, or 1 **mega**byte (1 MB). Scientists notate this as follows: 1000 x 1000 bytes equals 10 x 10 x 10 x 10 x 10 x 10 bytes, or 106 bytes.

In the metric system, something that equals one million times the standard value, is given the word ‘mega’. For each factor of 1000 times bigger, you get a different word that you add to the standard value. This is called a prefix. These are the prefixes you add:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number of times standard value** | **Written** | **Prefix** | **Symbol** | **Scientific notation** |
| 1000 x | One thousand | Kilo- | k | 1 x 103 |
| 1000.000 x | One million | Mega- | M | 1 x 106 |
| 1000.000.000 x | One billion | Giga- | G | 1 x 109 |
| 1000.000.000.000 x | One trillion | Tera- | T | 1 x 1012 |

You can also go smaller. For example: one thousandth (1/1000) of a litre is one millilitre. Scientists use a *negative power* to picture this. 1/1000 can be written as 10-3. See the minus (-) sign in there? This means you divide 1 by 10 x 10 x 10. So one millionth of a litre is 1 / 1000.000 of a litre or 10-6 litres. If you divide the standard value with a factor of one thousand, you also get different prefixes. Here are some examples:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Quantity** | **Notation** | **Written** | **Abbreviation** | **Scientific notation** |
| 1/1000 meters | 0,001 m | 1 millimeter | 1 mm | 1 x 10-3 grams |
| 1 / 1000.000 liters | 0,000001 L | 1 microliter | 1 µL | 1 x 10-6 liters |

See how the notation gives a lot of zeroes? That is why scientists use the scientific notation. Now look at that scientific notation and compare it with the ‘normal’ notation. If the scientific notation says 10-3, there are three zeroes before the 1 and the comma is placed after the first zero. If the scientific notation says 10-6, there are six zeroes before the 1 and the comma is placed after the first zero. Easy, right?

In the following table, you can see the notation for when a quantity is limited by a factor of 1000 and the corresponding prefixes:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number of times standard value** | **Written** | **Prefix** | **Symbol** | **Scientific notation** |
| 1 / 1000 x | One thousandth | Milli- | m | 1 x 10-3 |
| 1 / 1000.000 x | One millionth | Micro- | µ | 1 x 10-6 |
| 1 / 1000.000.000 x | One billionth | Nano- | n | 1 x 10-9 |
| 1 / 1000.000.000.000 x | One trillionth | Pico- | p | 1 x 10-12 |

**Now, let’s try and work with it!**

*Use your phone, tablet or a laptop to do this assignment.*

Go to **scaleofuniverse.com** and answer the following questions:

How big is the Eiffel tower? Give both the standard and the scientific notation.

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How big is the average giraffe?

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Calculate how many giraffes you could pile up to match the height of the Eiffel tower.

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And how many matchsticks would equal the height of the Eiffel tower?

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How wide is the minecraft world, according to this website?

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If you would line them up, how many giant earthworms would you need to go from the earth to the moon and back?

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Calculate how many of the biggest known viruses you would need to equal the length of the X-chromosome.

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And now a true brainteaser: if you would put an X and a Y chromosome alternately in line, how many chromosomes of each would you need to match the *Amphicoelias fragillimus?*

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