**ACTIVITY: Big numbers in science**

In this activity, students investigate the use of big numbers, such as millions and billions, throughout the Science Learning Hub. They encounter ways to understand what these big numbers mean.

By the end of this activity, students should be able to:

* recognise big numbers and the different ways they are written
* understand what these big numbers mean, at least in terms of their magnitude
* realise how widespread the use of big numbers is in science
* use the Science Learning Hub as an on-line research resource.

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**Introduction/background**

Understanding big numbers is important in many fields of science. When geologists talk about dating rocks, they refer to tens of thousands, millions and billions of years. Astronomers talk about vast distances in space that involve trillions of kilometres. Some scientists use instruments that cost millions or billions of dollars. These numbers are impressive, but what do they mean?

The main activity outlined here has students investigating big numbers used by a range of scientists. Before they do that, make sure they know how big numbers are written, as they will encounter different forms. Below are some ideas, but you may have your own methods, and prefer to skip straight to the main activity.

Here are some numbers up to a trillion. Your students could research bigger numbers, as the list goes on through quadrillion, quintillion and so on. There is even a googol, which is 1 with 100 zeros after it.

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| **Number in words** | **Number in numerals** | **Number of zeros after the 1** | **Scientific notation (number of zeros after the 1)** |
| Ten | 10 | 1 | 101 |
| One hundred | 100 | 2 | 102 |
| One thousand | 1,000 | 3 | 103 |
| Ten thousand | 10,000 | 4 | 104 |
| One hundred thousand | 100,000 | 5 | 105 |
| One million | 1,000,000 | 6 | 106 |
| One billion | 1,000,000,000 | 9 | 109 |
| One trillion | 1,000,000,000,000 | 12 | 1012 |

Give your students some big numbers written in numerals and have them write them out using words. For example:

* 20,102,326 – twenty million, one hundred and two thousand, three hundred and twenty six

Then have them convert words to numerals, for example:

* eleven million, two hundred and eight thousand, one hundred and thirty two – 11,208,132

In reality, few scientists, including geologists, use big numbers as precise as the examples above. They are more likely to refer to ‘rounded’ numbers, such as 54 million (54,000,000), or use a decimal place, such as 54.2 million (54,200,000).

There are many ways to try and help students understand what these big numbers actually mean. However, often it is enough to get an idea of the scale or magnitude of the numbers relative to other things, rather than expecting to really visualise the numbers.

One way to think about big numbers is to relate them to time.

Imagine you have won an amazing prize at your local shopping mall. You can spend $1 every second until the prize money runs out.

Obviously if you only win $10, it would take just 10 seconds to spend. How long would it take you to spend larger amounts of money?

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| **Amount of prize money to spend** | **How long it would take at $1 a second** |
| $10 | 10 seconds |
| $100 | 1 minute, 40 seconds |
| $1,000 | 18 minutes, 20 seconds |
| $10,000 | 3 hours, 5 minutes |
| $100,000 | 1 day, 4 hours |
| $1,000,000 (one million) | 11½ days |
| $1,000,000,000 (one billion) | 32 years |
| $1,000,000,000,000 (one trillion) | 32,000 years |

Another way to look at big numbers is using sheets of paper. You can do this using a ruler and some boxes of photocopying paper.

Measure how thick a pack of 500 sheets is (it will be about 55mm, though this will vary slightly).

Each sheet is 0.11mm thick (55mm ÷ 500).

Pile up 2 packs of paper (1,000 sheets). How high is the stack?

You can continue adding lots of 500, or pile up boxes of 5 packs (2500 sheets), until the stack gets unstable. What if you could carry on piling on the paper?

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| **Number of sheets of paper** | **Height** | **Comment** |
| 500 | 55mm |  |
| 1,000 | 110mm |  |
| 5,000 | 550mm |  |
| 10,000 | 1.1m |  |
| 100,000 | 11m | Measure this out or compare to a building at school. |
| 1,000,000 (one million) | 110m | The height of a building with about 30 floors, such as the Majestic Centre in Wellington. The Sky Tower in Auckland is three times that, at 328m – how many sheets of paper would stack this high? |
| 1,000,000,000 (one billion) | 110km | Heading towards the top of the atmosphere, but the International Space Station orbits at about 400km – how many sheets of paper would stack this high? |
| 1,000,000,000,000 (one trillion) | 110,000km | A third of the way to the Moon. |

There are two main options for this activity:

* Students have access to the Science Learning Hub on the internet. Arrange this to suit your circumstances. For example, you may use a single computer with data projector or an interactive whiteboard to carry out the web research as a class. If several computers are available, students can work online in groups or take turns.
* Students do not have access to the internet. Students still study big numbers, but without the element of conducting web research.

**What you need**

* Number hunt cards for students [using the internet](#2et92p0) or [not using the internet](#tyjcwt)

**What to do**

1. Introduce students to the Science Learning Hub. (Even if students will not be directly accessing it, it is the source of information used in the activity.)
2. Ask students what sorts of scientists they think might use really big numbers, and what for.
3. Divide the class into small groups and allocate number hunt cards (there are 18) depending on whether they are [using the internet](#2et92p0) or [not using the internet](#tyjcwt).
4. Point out that each number hunt card contains a reference to an article or video clip on the Science Learning Hub:

* Students using the internet should look up the reference.
* Students not using the internet should read the extract on the card.

1. Students should write down:

* one of the big numbers used, in the same form it is written in the extract.
* the number they found in a different way – if their number was written in words, they should write it in numerals and vice versa
* the type of scientist who used the number if it is obvious.

1. Ask students to arrange all the completed cards in order, from the smallest number to the largest.

**Discussion questions**

* How easy was it to put the numbers in order when they are written in different ways? What could you do to make it easier?
* Scientists aren’t the only people to use big numbers – who else might and what for?
* What was the biggest number? Who might use numbers bigger than this?
* Which scientists used the biggest numbers and why did they need them?

**Number hunt cards for students using** [**http://sciencelearn.org.nz**](http://sciencelearn.org.nz)

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| **1.** [**What is the Big Bang theory?**](http://link.sciencelearn.org.nz/videos/139-what-is-the-big-bang-theory) **video**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |
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| **2.**[**Cardiac muscle**](http://link.sciencelearn.org.nz/images/2362-cardiac-muscle) **image**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |
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| **3.** [**Carbon cycle**](http://link.sciencelearn.org.nz/image_maps/3-carbon-cycle) **interactive**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |
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| **4.** [**Increasing atmospheric carbon dioxide**](http://link.sciencelearn.org.nz/videos/221-increasing-atmospheric-carbon-dioxide) **video**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **5.** [**Radio telescopes of the future**](http://link.sciencelearn.org.nz/videos/920-radio-telescopes-of-the-future) **video**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **6.** [**Water distribution**](http://link.sciencelearn.org.nz/videos/920-radio-telescopes-of-the-future) **video**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **7.** [**Colliding galaxies**](http://link.sciencelearn.org.nz/resources/1623-colliding-galaxies) **article**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **8.** [**Week 5: Plankton in the Ross Sea article**](http://link.sciencelearn.org.nz/resources/1279-week-5-plankton-in-the-ross-sea) (marine bacteria paragraph)  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **9.** [**Landcare Research’s insect collection**](http://link.sciencelearn.org.nz/resources/1433-landcare-research-s-insect-collection) **article**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |
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| **10.** [**Cells**](http://link.sciencelearn.org.nz/resources/175-cells) **article**  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

**Number hunt cards for students not using** [**http://sciencelearn.org.nz**](http://sciencelearn.org.nz)

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| **1.** [**What is the Big Bang theory?**](http://link.sciencelearn.org.nz/videos/139-what-is-the-big-bang-theory) **video**  The Big Bang theory essentially states that there was some kind of expansion of space at some distant point in time, approximately 13 and a half, 14 billion years ago. An expansion of space itself.  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |
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| **2.** [**Cardiac muscle**](http://link.sciencelearn.org.nz/images/2362-cardiac-muscle) **image**  Cardiac muscle is a specialised kind of muscle found only within the heart. This muscle pumps blood through the body. The average person’s heart beats more than 4,000 times in an hour, so, by time you turn 70, your heart will beat some two-and-a-half billion times. Cardiac muscle, like smooth muscle, does not tire.  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **3.** [**Carbon cycle**](http://link.sciencelearn.org.nz/image_maps/3-carbon-cycle) **interactive** The carbon cycle overlaps the rock cycle. Ocean sediments and the rocks they turn into contain huge amounts (1,000,000,000 billion tonnes) of carbon. This is mostly in calcite and limestone. **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |
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| **4.** [**Increasing atmospheric carbon dioxide**](http://link.sciencelearn.org.nz/videos/221-increasing-atmospheric-carbon-dioxide) **video**  We are emitting about 9 petagrams of carbon per year to the atmosphere through fossil fuels. Scientists like to talk about carbon in terms of petagrams of carbon per year. To you and me, that petagram of carbon per year is a billion metric tonnes of carbon per year.  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **5.** [**Radio telescopes of the future**](http://link.sciencelearn.org.nz/videos/920-radio-telescopes-of-the-future) **video**  The idea that has come about is the idea of the square kilometre array, which is an array of radio dishes which has the collecting area of one square kilometre. A consortium of 17 countries has been working for many years now to try and get this together. It will be a billion dollar project or 2 billion dollar project.  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **6.** [**Water distribution**](http://link.sciencelearn.org.nz/videos/358-water-distribution) **video**  The total amount of water on Earth is estimated to be between 1–2 billion cubic kilometres. This amount is finite.  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **7.** [**Colliding galaxies**](http://link.sciencelearn.org.nz/resources/1623-colliding-galaxies) **article**  The 100 billion galaxies in the universe are not just scattered randomly in space. Most galaxies are arranged in small groups or larger clusters.  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |
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| **8.** [**Week 5: Plankton in the Ross Sea**](http://link.sciencelearn.org.nz/resources/1279-week-5-plankton-in-the-ross-sea) **article**  With 10 to 20 thousand bacterial species in 1 litre of seawater, microbes in the ocean represent the greatest biomass on the planet. Bacterial numbers can be even as high as a billion per litre.  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **9.** [**Landcare Research’s insect collection**](http://link.sciencelearn.org.nz/resources/1433-landcare-research-s-insect-collection) **article**  The arthropod (insects and relatives) collection was started in 1920 and now contains over 6 million different specimens of insects – 90% of specimens were collected in New Zealand, and 18,000 species are regarded as endemic to New Zealand.  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |

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| **10.** [**Cells**](http://link.sciencelearn.org.nz/resources/175-cells) **article**  A cell is the smallest basic unit that you are made up of. One cell contains all the genetic information necessary to make a human being. When you look at yourself in the mirror, you’re seeing about 10 trillion cells  **What is the big number?**  **Write it in a different way**  **What type of scientists used the number?** |