# Mathematical shorthand

Students discover the need for, and learn about scientific notation for large numbers by, examining distances and weights of planets in our solar system.

## Visible learning

### Learning intention

* To be able to express large numbers in scientific notation.

### Success criteria

* I can recognise when a number is written in scientific notation.
* I can convert large numbers in decimal form to scientific notation.
* I can convert large numbers in scientific notation to decimal form.
* I can enter numbers into my calculator when in scientific notation.

### Syllabus outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* solves measurement problems by using scientific notation to represent numbers and rounding to a given number of significant figures **MA5-MAG-C-01**

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## Activity structure

### Launch

1. Pose the following question: ‘How far are we from other planets or the sun?’
2. Get students to go to the website *‘*If the moon were only 1 pixel’ ([joshworth.com/dev/pixelspace/pixelspace\_solarsystem.html](https://www.joshworth.com/dev/pixelspace/pixelspace_solarsystem.html)) and give them time to discover and manipulate without any instructions.
3. Give students a copy of Appendix A *‘*How far apart are the planets?’ and get them to use the website to complete the table.
4. Conduct a Think-Pair-Share ([bit.ly/DLSthinkpairshare](https://bit.ly/DLSthinkpairshare)) where they discuss with a partner what they noticed about the activity and what they wonder about the activity.

The aim is for students to appreciate the need to be able to express very big numbers in a more simplistic way.

### Explore

1. Appendix B ‘How heavy are our planets?’ lists the mass of each planet in kilograms.
2. Have students engage in another Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)) to arrange the planets in order from heaviest to lightest and explain how they made their decisions about the order.
3. Hand out or display Appendix C ‘How heavy are our planets? (Scientific notation)’ and have students construct a notice and wonder list ([bit.ly/noticewonderstrategy](https://bit.ly/noticewonderstrategy)) comparing the masses in Appendix B and C.

Prompt students to direct their attention to the powers of 10 of each number and compare them between the different measurements. Separately, prompt students to compare the decimal at the front of the expression for each of the measurements. Encourage discussion about why 10 is used as a multiple.

1. As a class, discuss how you could express the distances found in Appendix A ‘How far apart are the planets?’ using our knowledge of powers of 10s.

### Summarise

1. Use slides 1–17 of the *Mathematical shorthand* PowerPoint for explicit teaching of the skills required for writing large numbers in scientific notation.

The explicit teaching technique used in the associated PowerPoint is ‘Your turn.’ The first slide is a worked example which should be displayed for the students and then use the following steps.

1. Reveal the question to students and its solution.
2. Students read in silence.
3. Students individually think and explain to themselves what is happening in each step.
4. Students hold up a thumbs up to the teacher when they have finished reading and have some sort of understanding.
5. Think-Pair-Share. Students explain the solution to their partner.
6. In pairs, students then answer the self-explanation questions.
7. Finally, randomly select students to share their answers with the whole class.
8. Demonstrate to students how to use their calculator to express large numbers in scientific notation.
9. Ask students to write notes to their future forgetful self ([bit.ly/notesstrategy](https://bit.ly/notesstrategy)) to help them remember how to transition between scientific notation and decimal form.
10. Students can now complete the last column in the table in Appendix A ‘How far apart are the planets?’ to convert the planet distances to scientific notation.

### Apply

1. Give students a copy of Appendix D ‘Converting large numbers’. This activity allows students to convert between scientific notation and decimal form and vice versa as well as calculate some examples from biology and physics.

These questions have been designed to go from easy to hard and then into problem solving activities.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* Students could work in groups to do the first activity. Finding all the lengths could be a difficult task for some students. The focus is to get students to write out the long numbers.
* Students may need guidance on using the website. The icons at the top of the page direct you to each planet.

**Explore**

* Teachers may need to revise 10 to the power of different numbers. ‘Math interactives’ provides a quick, interactive activity for students if required ([bit.ly/powersof10review](https://bit.ly/powersof10review)).

**Summarise**

* Teachers may need to revise rounding numbers to significant figures.
* Provide examples where significant figures are disregarded to allow students to focus on just scientific notation.
* Round numbers in the table to 2 or 3 significant figures and present to students.

**Apply**

* More simple or complex examples can be added to the table to meet student’s needs.

### Suggested opportunities for assessment

**Summarise**

* **Collect notes to future self to check for misconceptions and ensure students have the correct process moving forward.**
* Create an exit ticket where students need to choose 2 examples from Appendix A and write in scientific notation to 3 significant figures.

**Apply**

* Appendix C ‘How heavy are our planets? (Scientific notation)’ could be collected and used as summative assessment for this unit of learning.

## **Appendix A**

### How far apart are the planets?

|  |  |  |
| --- | --- | --- |
| Planets | Distance from the sun (km) |  |
| Mercury |  |  |
| Venus |  |  |
| Earth |  |  |
| Mars |  |  |
| Jupiter |  |  |
| Saturn |  |  |
| Uranus |  |  |
| Neptune |  |  |
| Pluto |  |  |

|  |  |  |
| --- | --- | --- |
| Planets | Distance from Earth (km) |  |
| Mercury |  |  |
| Venus |  |  |
| Earth |  |  |
| Mars |  |  |
| Jupiter |  |  |
| Saturn |  |  |
| Uranus |  |  |
| Neptune |  |  |
| Pluto |  |  |

## **Appendix B**

### How heavy are our planets?

|  |  |
| --- | --- |
| Planets | Absolute mass of the planets (kg) |
| Mercury | 330 100 000 000 000 000 000 000 |
| Venus | 4 867 000 000 000 000 000 000 000 |
| Earth | 5 972 000 000 000 000 000 000 000 |
| Mars | 641 700 000 000 000 000 000 000 |
| Jupiter | 1 899 000 000 000 000 000 000 000 000 |
| Saturn | 568 500 000 000 000 000 000 000 000 |
| Uranus | 86 820 000 000 000 000 000 000 000 |
| Neptune | 1 024 000 000 000 000 000 000 000 000 |
| Pluto | 14 720 000 000 000 000 000 000  |

## **Appendix C**

### How heavy are our planets? (Scientific notation)

|  |  |
| --- | --- |
| Planets | Absolute mass of the planets (kg) |
| Mercury | 3.301 × 1023 |
| Venus | 4.867 × 1024 |
| Earth | 5.972 × 1024 |
| Mars | 6.417 × 1023 |
| Jupiter | 1.899 × 1027 |
| Saturn | 5.685 × 1026 |
| Uranus | 8.682 × 1025 |
| Neptune | 1.024 × 1027 |
| Pluto | 1.472 × 1022 |

## **Appendix D**

### **Converting large numbers**

|  |  |  |
| --- | --- | --- |
|  | Decimal form | Scientific notation |
| **1.** | **200 000** |  |
| **2.** |  | **4 × 103** |
| **3.** |  | **6.48 × 107** |
| **4.** | **4 980** |  |
| **5.** | **2 130 250** |  |
| **6.** |  | **1.6 × 101** |
| **7.** |  | **7.77 × 100** |
| **8.** |  | **8 × 102+ 1.5 × 103** |
| **9.** | **Speed of light:** |  |

**Answer the following questions leaving your answer in scientific notation.**

1. **The earth orbits the sun on an almost circular path of average radius approximately
149 598 000 000 m. Approximate the total distance travelled by the Earth in one year.**
2. **It is estimated that 1 g of fertile soil contains approximately 2 500 million bacteria. How many bacteria can be found in a garden bed containing a tonne of fertile soil?**
3. **There are approximately 3 × 105 platelets in a ml of human blood. If 7% of the bodies weight is blood (in litres), approximately how many platelets do you have?**

**Challenge:**

1. **What is the largest number you can enter in your calculator in scientific notation?**
2. **What is the largest calculation you can get your calculator to perform?**

## Sample solutions

### Appendix A – how far apart are the planets?

|  |  |  |
| --- | --- | --- |
| Planets | Distance from the sun (km) | Distance in scientific notation |
| Mercury | 59 426 029.6 km | 5.94 × 107 |
| Venus | 108 457 778.7 km | 1.08 × 108 |
| Earth | 149 861 174.4 km | 1.50 × 108 |
| Mars | 228 157 689.1 km | 2.28 × 108 |
| Jupiter | 778 772 176 km | 7.79 × 108 |
| Saturn | 1 433 364 338.5 km | 1.43 × 109 |
| Uranus | 2 877 275 780.9 km | 2.88 × 109 |
| Neptune | 4 504 531 787.7 km | 4.50 × 109 |
| Pluto | 5 907 889 708 km | 5.91 × 109 |

|  |  |  |
| --- | --- | --- |
| Planets | Distance from the Earth (km) | Distance in scientific notation |
| Mercury | 90 435 144.8 km | 9.04 × 107 |
| Venus | 41 403 395.7 km | 4.14 × 107 |
| Earth | 0 km | 0 × 100 |
| Mars | 78 296 514.7 km | 7.83 × 107 |
| Jupiter | 628 911 001.6 km | 6.29 × 108 |
| Saturn | 1 283 503 164 km | 1.28 × 109 |
| Uranus | 2 727 414 607 km | 2.73 × 109 |
| Neptune | 4 354 670 613 km | 4.35 × 109 |
| Pluto | 5 758 028 534 km | 5.76 × 109 |

### Appendix D – converting large numbers

|  |  |  |
| --- | --- | --- |
|  | Decimal form | Scientific notation |
| **1.** | **200 000** | **2.0 × 105** |
| **2.** | **4 000** | **4 × 103** |
| **3.** | **64 800 000** | **6.48 × 107** |
| **4.** | **4 980** | **4.98 × 103** |
| **5.** | **2 130 250** | **2.13 × 106** |
| **6.** | **16** | **1.6 × 101** |
| **7.** | **7.77** | **7.77 × 100** |
| **8.** | **2 300** | **8 × 102+ 1.5 × 103** |
| **9.** | **Speed of light (m/s): 3 000 000 000** | **3.00 × 109** |

1. **An example for a student who weighs 65 kg.**

## References

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