# How big is the nanoscale?

***Education in Chemistry***January 2018[rsc.li/EiC118-preciouswater](http://www.rsc.li/EiC118-preciouswater)

**These exercises accompany the above article ‘Precious Water’.**

**Exercise 1:** Draw lines to match up the measurement described with the appropriate value and unit.

|  |  |  |
| --- | --- | --- |
| Height of an average  sized horse |  | 20 metres |
| Width of an E string  on an acoustic guitar |  | 231 pm |
| Width of a strand  of DNA |  | 0.254 mm |
| Height of a Scots  pine tree |  | 16 hands |
| Average height of  an adult female |  | 100 microns |
| Atomic radius of  Calcium |  | 2.5 nanometres |
| Thickness of a  piece of paper |  | 160 cm |

**Exercise 2:** Skim read the article ‘Precious water’. Below are six sentences showing some figures given in the article. Complete the sentences to give a full account of what the figure is describing. The first one is done for you.

Eg, 416,000 *…… km of mains water pipes in the UK….*

1. 5–100nm………………………………………………………………………………………………....
2. 18,000…………………………………………………………………………………………………….
3. 5 …………………………………………. a day, ………………………………………………………
4. 150–200………………………………………………………………………………………………….
5. 40,000–50,000…………………………..………............. during ……………….…………in 2016.
6. 1–5…………………………………………………………………………………………………………

**Exercise 3:** Below is a table with the measurements considered earlier. The measurements have been converted into metres and into nanometres in the first two rows. Complete the rest of the table.

To convert between metres and nanometres you will need to become familiar with the x10x button on your calculator, and your calculator will convert the answer to standard form for you. If you get stuck with this, get your teacher to show you how to use your calculator to do these conversions.

When converting m to nm you can add x109 to any figure in m.

When converting nm to m you can add x10-9 to any figure in nm.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Measurement** | **In metres** | **In nm** |
| Height of an average  sized horse | **16 hands** | **1.63** | **1.63 x109** |
| Width of an E string  on an acoustic guitar | 0.254mm | 0.000254 |  |
| Width of a strand  of DNA | **2.5nm** | **2.5x10-9** | **2.5** |
| Height of a Scots  pine tree | 20m |  |  |
| Average height of  an adult female | 160cm |  | 1.6 x109 |
| Atomic radius of  Calcium | 231pm | 2.31 x10-10 |  |
| Thickness of a  piece of paper | 100microns | 1 x10-4 |  |

**Exercise 4:** **Considering relative size**

You will need: a pack of icon cards and a roll of toilet paper.

1. Roll out the toilet paper so you have 12 sheets in total.
2. Mark up each sheet with a power of ten scale in nanometres, x101 nm, x102 nm etc.
3. Place each icon card in the right place on your toilet paper scale.

Use reference materials (books, the internet) to find out the measurements of some things you consider very small. Convert these measurements to nanometres and put the cards on the scale.

**Icon cards for exercise 4**

|  |  |
| --- | --- |
|  | Average height of an adult female |
| Height of an average sized horse | Width of an E string on an acoustic guitar |
| Width of a strand of DNA | Atomic radius of calcium |
| Height of a Scots pine tree | Thickness of a piece of paper |