

Measuring low concentrations

What do ppm, ppb, ppt and ppq stand for ?

"Parts per" is the usual way scientists talk about low and very low contents, or concentrations, of say a pollutant in water, air or soil. Over the past 50 years, chemists have developed the ability to detect smaller and smaller amounts of any substance in our food and water.

Abbreviation	Notation	Equivalence	Just how small is that exactly?	Comment
ppm	parts per million	1 ppm = 1 part in 1 million (10^6) = 1 mg/L	<ul style="list-style-type: none"> - 1 second in 280 hours - 1 cent in €10,000 - 1 cm in 10 km - 1 teaspoon of water in a hot bath full of water 	These measures have been 'standardised' in chemistry and physics text books at the ppm level from around the 1920s onwards.
ppb	parts per billion	1 ppb = 1 part in 1 billion (10^9) = 1 µg/L	<ul style="list-style-type: none"> - 1 second in 32 years - 1 cent in €10 million - 1 cm in 10,000 km - 1 drop of impurity in 500 barrels of water (or some 75,000 litres of water) - 1 sheet in a roll of toilet paper stretching from New York to London - 1 pinch of salt in 10 tons of potato chips 	Ppb became common in the 1960s as analytical techniques improved.
ppt	parts per trillion	1 ppt = 1 part in 1 trillion (10^{12}) = 1 ng/L	<ul style="list-style-type: none"> - 1 second in 320 centuries - 1 cent in €10 billion - 1 cm in 10 million km (more than 600 times around the Earth) - 1 drop of impurity in 500,000 barrels of water (or some 75 million litres of water) - 1 grain of sand in an Olympic size swimming pool (50 X 25 m) 	<p>The remarkable advances in the sensitivity of modern analytical techniques in the 1980s make it possible to detect some substances at the ppt level whose presence would not have been detected using earlier assay methods.</p> <p>!!! ppt can be confusing as it is sometimes used for parts per thousand</p>
ppq	parts per quadrillion	1 ppq = 1 part in 1 quadrillion (10^{15}) = 1 pg/L	<ul style="list-style-type: none"> - 1 second in 32 million years - 1 cent in €10 trillion - 1 cm in 10 billion km (or 0.15 mm distance travelled on the way to the Sun!) - 1 drop of impurity in 500,000,000 barrels of water (or some 75 billion litres of water) - 1 human hair out of all the hair on all the heads of all the people in the world 	There are no known analytical techniques that can measure with this degree of accuracy; nevertheless, it is used in some mathematical models of toxicology and epidemiology.