The Scale of the Universe

Powers of Ten

Numbers in science - particularly astronomy, can be extremely small or extremely large.

Use *scientific notation*:

$$10 = 10^1 = 1.0 \times 10^1 = 1.0\text{e}1$$

$$100 = 10^2 = 1.0 \times 10^2 = 1.0\text{e}2$$

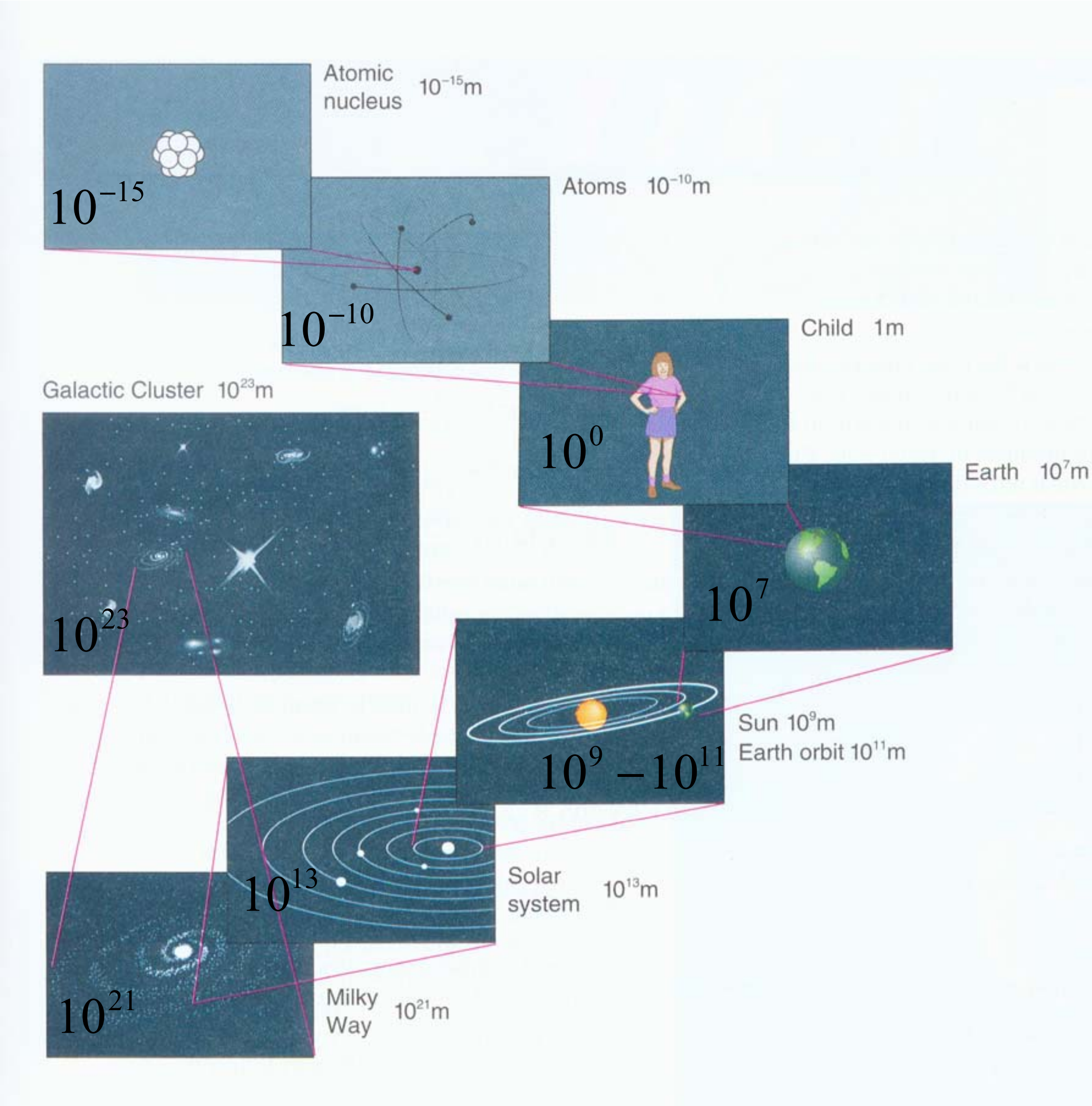
$$0.01 = 10^{-2} = 1.0 \times 10^{-2} = 1.0\text{e}-2, \text{ etc.}$$

All numbers can be expressed in scientific notation.

$$3150 = 3.15 \times 10^3$$

$$0.00025 = 2.5 / 10^4 = 2.5 \times 10^{-4}$$

Relative Sizes



If the Sun were the size of a basketball, the Earth would be the head of a pin 90 feet away!

The vast majority of the universe is empty space. Matter is also mostly empty space.

Significant Figures

In science, most numbers are ultimately based upon measurements. Since measurements are uncertain, use only those numbers that are meaningful, e.g., a standard ruler can measure 8.5 cm, not 8.50321 cm!

Rules of *significant figures*:

1. Non-zero digits are always significant.

2. Any zeros between two significant figures are significant.

3. A final zero or trailing zeros in the decimal portion ONLY are significant.

Examples with significant digits in boldface:

0.0**234**, 0.00**500**, **408**0, **2**00, **2.00** x 10^2, **4.500** x 10^{12}.

Significant Figures

Rule for addition and subtraction - round the final result to the least number of decimal places, regardless of the significant figures of any one term, for example:

$$
\begin{array}{r}
1.007 \\
13.32 \\
+\,0.0011 \\
\text{---------} \\
14.3281 \;\; \text{rounds off to } 14.33.
\end{array}
$$

Rule for multiplication and division - round the final result to the least number of significant figures of any one term, for example:

$$\frac{(5.37)(11.03)}{1.925} = 30.7694 \text{ rounds off to } 30.8.$$