Standard form (sometimes referred to as 'scientific notation') is a way of expressing *large* and *small* numbers **clearly** and **efficiently**

2.998×10^{8} Speed of light in a vacuum /ms^{-1}

3.432×10^{2} Speed of sound in dry air at 20°C /ms^{-1}

6.371×10^{6} Radius of Earth /m

5.97×10^{24} Mass of Earth /kg

1.989×10^{30} Mass of the Sun /kg

1.95×10^{2} UK energy consumption kWh/person/day

6.323×10^{7} UK population 2013

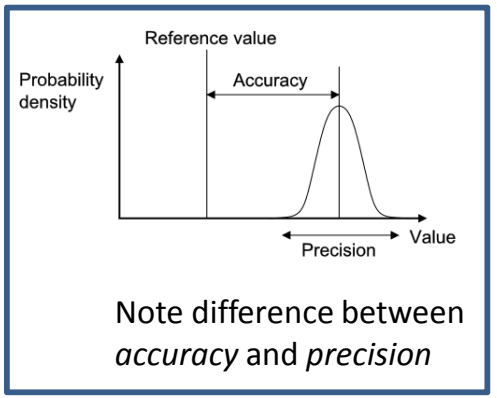
6.95×10^{11} UK Government spending 2011 / £

$$c = 2.998\times10^{8}\ \text{ms}^{-1}$$

1,2,3,4,5,6, 7,8, or 9 *not* 0

The number of **significant figures** required to quantify the **precision** of the number (in this case 4)

A power of ten. To "within an order of magnitude" indicates the size of the number. In this case about 3 **hundred million**



Note difference between *accuracy* and *precision*

Prefix	English word	10^{x}
deca (da)	ten	10^{1}
hecto (h)	hundred	10^{2}
kilo (k)	thousand	10^{3}
mega (M)	million	10^{6}
giga (G)	billion	10^{9}
tera (T)	trillion	10^{12}
peta (P)	quadrillion	10^{15}
exa (E)	quintillion	10^{18}
zetta (Z)	sextillion	10^{21}
yotta (Y)	septillion	10^{24}

Prefix	English word	10^{x}
	one, unity	10^{0}
deco (d)	tenth	10^{-1}
centi (c)	hundredth	10^{-2}
milli (m)	thousandth	10^{-3}
micro (μ)	millionth	10^{-6}
nano (n)	billionth	10^{-9}
pico (p)	trillionth	10^{-12}
femto (f)	quadrillionth	10^{-15}
atto (a)	quintillionth	10^{-18}
zepto (z)	sextillionth	10^{-21}
yocto (y)	septillionth	10^{-24}

1.496×10^{11} Astronomical Unit (AU) /m

3.0857×10^{16} Parsec/m

9.4607×10^{15} light year /m

$(1.3798\pm0.0037)\times10^{10}$ Age of Universe / years

4.7×10^{10} Radius of observable universe / light years

5.92×10^{0} Volume of one imperial teaspoon /ml or cm^3

Volume of universe in tsp

$$V = \tfrac{4}{3}\pi R^3 = \tfrac{4}{3}\pi\left(4.7\times10^{10}\times9.4607\times10^{15}\right)^3$$

$$= 3.6826\times10^{80}\ \text{m}^3$$

$$1\,\text{tsp} = 5.92\,\text{cm}^3 = 5.92\times\left(10^{-2}\,\text{m}\right)^3 = 5.92\times10^{-6}\,\text{m}^3$$

$$\therefore V = \frac{3.6826\times10^{80}}{5.92\times10^{-6}} = 6.22\times10^{85}\ \text{tsp}$$

Standard form can be used to approximate calculations with big numbers. e.g. volume of the earth in cubic metres

$$V = \tfrac{4}{3}\pi R^3$$
$$= \tfrac{4}{3}\pi\left(6.371\times10^6\right)^3 = 1.083\times10^{21}$$
$$\approx \frac{4\times3}{3}\times6^3\times10^{18}$$
$$= 4\times216\times10^{18}$$
$$\approx 10^{21}$$

Take care to use the **laws of indices** properly when calculating with numbers in standard form

$$3\times10^3 + 2\times10^2 = 10^2\times\left(3\times10^1 + 2\right) = 3.2\times10^3$$

$$100\times10^5 \div 0.01\times10^{-3} = \frac{10^7}{10^{-5}} = 10^{12}$$

$$x^a x^b = x^{a+b}$$
$$\left(x^a\right)^b = x^{ab}$$
$$x^{-a} = \frac{1}{x^a}$$
$$\sqrt[n]{x} = x^{\frac{1}{n}}$$

$$314\times10^{-1} + 27.2\times10^{-3}$$
$$= 3.14\times10^1 + 2.72\times10^{-2}$$
$$= 3.14\times10^1 + 0.00272\times10^1$$
$$= 3.14272\times10^1$$

Sometimes you need to choose a particular power of ten to add or subtract numbers in standard form

$$\sqrt[7]{10^{212} + 2\times10^{211} + 8\times10^{210}}$$
$$= \left(128\times10^{210}\right)^{\frac{1}{7}}$$
$$= \left(2^7\times10^{7\times30}\right)^{\frac{1}{7}}$$
$$= 2\times10^{30}$$

A test of your knowledge of standard form indices and powers of small integers!