M.3 Standard form

In physics we deal with very large numbers and very small numbers.

For example, the speed of light in a vacuum is 300 000 000 m/s, and the size of the atom is approximately 0.000 000 0001 m.

We can use the standard form notation to make it easier to write and manipulate large and small numbers.

In standard form we write the speed of light as $3 \times 10^8 \; m/s$. It means that we multiply 3 by $10^8 (= 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10)$ (i.e. multiply 3 by 10, eight times). Remember that multiplying by 10 moves the 3 one decimal place to the left.

$$\times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$$

$$300\ 000\ 000 \; m/s$$
$$= 3 \times 10^8 \; m/s$$

Worked example:
Question. What is 629000 in standard form?

Think

What do we need to multiply 6.29 by to equal 629 000?

$$629\ 000 = 6.29 \times 100\ 000$$
$$= 6.29 \times (10 \times 10 \times 10 \times 10 \times 10) \; (i.e.\ 5\ places\ to\ the\ left)$$
$$= \underline{6.29 \times 10^5}$$

1) ✎ Write the following is standard form: i) 459 000 000, ii) 35 000, iii) 357, iv) 2398

In standard form we write the approximate size of the atom as $1 \times 10^{-10}\ m$. It means that we divide 1 by $10^{10} (= 1 \div (10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10)$ (i.e. divide 1 by 10, ten times). Remember that dividing by 10 moves the 1 one decimal place to the right.

$$\div 10 \div 10 \div 10 \div 10 \div 10 \div 10 \div 10 \div 10 \div 10 \div 10$$

$$0.000\ 000\ 000\ 1\ m$$
$$= 1 \times 10^{-10}\ m$$

Worked example:
Question. What is 0.000582 in standard form?

Think

What do we need to divide 5.82 by to equal 0.000582?

$$0.000582 = 5.82 \div 10\ 000$$
$$= 5.82 \div (10 \times 10 \times 10 \times 10)\ (i.e.\ 4\ places\ to\ the\ right)$$
$$= \underline{5.82 \times 10^{-4}}$$

2) ✎ Write the following is standard form: i) 0.035, ii) 0.000 071, iii) 0.000 83, iv) 0.000 000 000 23

Multiplying in standard form

Look what happens when we multiply two standard form numbers together:

add

$$(5.7 \times 10^{3}) \times (3.2 \times 10^{5})$$

multiply

$$= 18.24 \times 10^{8}$$

Which we can further simplify to:
$$= \underline{1.824 \times 10^{9}}$$

3) ✎ Multiply together the two numbers in each case: i) $4.7 \times 10^{3}, 1.2 \times 10^{2}$, ii) $9.11 \times 10^{5}, 1.13 \times 10^{8}$, iii) $6.43 \times 10^{-4}, 4.12 \times 10^{5}$, iv) $5.3 \times 10^{-2}, 8.7 \times 10^{-5}$

Dividing in standard form

Look what happens when we divide two standard form numbers together:

$$\text{divide} \left\langle \frac{(5.7 \times 10^3)}{(3.2 \times 10^5)} \right\rangle \begin{array}{l} \text{subtract} \\ (3\text{-}5) \end{array}$$

$$= \underline{2.5 \times 10^{-2}}$$

4) ✏ Divide the first number by the second in each case: i) 4.7×10^3, 1.2×10^2, ii) 9.11×10^5, 1.13×10^8, iii) 6.43×10^{-4}, 4.12×10^5, iv) 5.3×10^{-2}, 8.7×10^{-5}
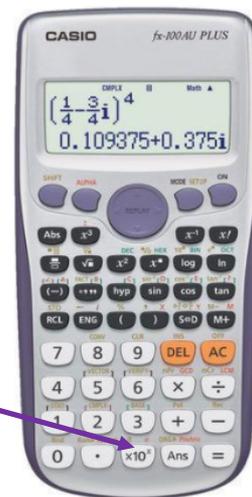
Using the calculator button for standard form

Most modern calculators have a button that you can use for standard form calculations.

For example, if you need to enter 3.45×10^5 into your calculator:

Type 3.45, press the $\boxed{\times 10^x}$ button and enter 5.

button for standard form

Note: On some calculators, this button is shown as $\boxed{\text{EXP}}$.