## Scientific Notation (Standard Form)

**Definition: Scientific Notation** (also known as Standard Form) is a more efficient way of showing really large or really small numbers.

**Definition:** a number written normally is said to be "in **normal form**".

- A really large number (one that ends with zeroes e.g. 560 000 or 31 million) will have a *positive* number in the power when written in scientific notation

- A really small number (one that begins 'zero point…' e.g. 0·02 or 0·00015) will have a *negative* number in the power when written in scientific notation

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Examples 1

| Normal Form | Scientific Notation |
|---|---|
| 92 000 000 | $9 \cdot 2 \times 10^{7}$ |
| 0·000456 | $4 \cdot 56 \times 10^{-4}$ |
| 305 000 | $3 \cdot 05 \times 10^{5}$ |

In the exam, you will be expected to use scientific notation in calculations. Make sure you know which buttons to use on your calculator for scientific notation – for instance on some calculators the scientific notation is written $\boxed{\text{EXP}}$ and you do not need to type in the ×10.

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Example 2

**One light year is approximately $9 \cdot 46 \times 10^{12}$ kilometres.**
**How many <u>metres</u> are there in 18 light years?**
**Give your answer in scientific notation.**

**Solution**

First notice that this question asks for the answer to be given in metres, so we have to convert from kilometres to metres. We do this by multiplying by 1000.

Therefore our sum is $9 \cdot 46 \times 10^{12} \times 18 \times 1000$

The answer is $\underline{1 \cdot 7028 \times 10^{17}}$ metres.

## Exercise 1

**1.** Rewrite these sentences with the numbers written out in full

**a)** The speed of light is $3 \times 10^8$ metres per second.

**b)** The diameter of the earth is $1 \cdot 268 \times 10^4$ kilometres.

**c)** A Building Society has £$2.15 \times 10^9$ in its funds.

**d)** The radius of the orbit of an electron is $5 \times 10^{-8}$ mm.

**e)** A space probe reached a speed of $1 \cdot 49 \times 10^5$ m.p.h.

**f)** The earth weighs $6 \cdot 6 \times 10^{21}$ tonnes.

**g)** A film of oil is $8 \times 10^{-7}$ mm thick.

**2.** Use your calculator to answer the following, giving your answers in Standard Form.

**a)** $(2 \cdot 2 \times 10^5) \times (4 \times 10^6)$

**(b)** $(3 \cdot 15 \times 10^7) \times (2 \cdot 2 \times 10^8)$

**c)** $(1 \cdot 8 \times 10^3) \times (2 \cdot 3 \times 10^4)$

**(d)** $(9 \cdot 1 \times 10^6) \times (1 \cdot 5 \times 10^{12})$

**e)** $(1 \cdot 4 \times 10^{13}) \times (4 \cdot 9 \times 10^{11})$

**(f)** $(2 \cdot 3 \times 10^5) \times (2 \cdot 4 \times 10^7)$

**g)** $(4 \cdot 25 \times 10^4) \times (2 \cdot 8 \times 10^2)$

**(h)** $(1 \cdot 95 \times 10^{-8}) \times (3 \cdot 2 \times 10^9)$

**i)** $(8 \cdot 7 \times 10^5) \times (7 \cdot 3 \times 10^{-10})$

**(j)** $(5 \cdot 05 \times 10^{-21}) \times (1 \cdot 8 \times 10^{-17})$

**k)** $(2 \cdot 2 \times 10^{15}) \div (4 \times 10^8)$

**(l)** $(3 \cdot 15 \times 10^4) \div (5 \times 10^{13})$

**m)** $(1 \cdot 8 \times 10^{23}) \div (2 \cdot 4 \times 10^7)$

**(n)** $(1 \cdot 302 \times 10^{14}) \div (1 \cdot 4 \times 10^8)$

**o)** $(1 \cdot 131 \times 10^{18}) \div (8 \cdot 7 \times 10^{10})$

**(p)** $(8 \cdot 25 \times 10^5) \div (3 \cdot 3 \times 10^{-7})$

**q)** $(4 \cdot 25 \times 10^{-14}) \div (2 \cdot 5 \times 10^{-5})$

**(r)** $(8 \cdot 82 \times 10^{-22}) \div (6 \cdot 3 \times 10^{11})$

**s)** $(9 \cdot 167 \times 10^4) \div (1 \cdot 03 \times 10^{-4})$

**(t)** $(6 \cdot 846 \times 10^{34}) \div (6 \cdot 52 \times 10^{15})$

**u)** $\dfrac{1 \cdot 28 \times 10^6}{0 \cdot 4 \times 10^2}$

**(v)** $\dfrac{4 \cdot 17 \times 10^2}{3 \times 10^{-3}}$

**w)** $\dfrac{18 \times 10^{-2}}{0 \cdot 2 \times 10^5}$

**3.** Answer each of the following questions leaving your answers in standard form.

**a)** Light travels at $1 \cdot 85 \times 10^5$ miles per second. How far will it travel in an hour?

**b)** The radius of the earth is $6 \cdot 45 \times 10^6$ metres.
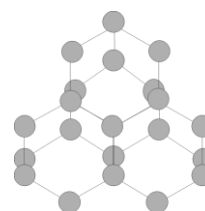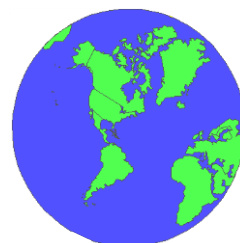What is its circumference (in km)?

**c)** If a heart beats 70 times a minute, how many times will it beat
in a lifetime of 80 years? [Take all years to have 365 days]

**d)** 100 grams of water contains 2000 drops.
How many drops would there be in a tank containing 1 tonne of water?

**e)** In 1 gram of carbon there are $6 \times 10^{26}$ atoms.
How many carbon atoms are there in 5kg of pure carbon?

**4.** Answer each of the following questions leaving your answers in standard form

**a)** The weight of a droplet of water is $8 \cdot 7 \times 10^{-5}$ grams.
Calculate the weight of 10 000 droplets.

**b)** A space probe can travel at a speed of $3 \cdot 6 \times 10^6$ miles per day.
What distance will it travel in a week?

**c)** A biscuit factory produces $6 \cdot 7 \times 10^6$ teacakes every day.
How many teacakes were produced in the month of **February 2008**?

**d)** The speed of light is approximately 299 million metres per second.
How far can light travel in a minute?

**e)** Last year $1 \cdot 68 \times 10^6$ copies of a DVD were sold on its first day of release.
If the cost of one DVD was £12, how much money was collected on that first day?

**f)** In a reality TV show there were $7 \cdot 9 \times 10^6$ calls made to vote for the contestants.
If each call cost 24p calculate how much the calls cost in total. Give your answer in pounds.

**g)** There are $8 \cdot 64 \times 10^4$ seconds in one day. How many seconds are there in the month of April?

**h)** Organisers of the London Marathon provide enough water to give each runner 7 litres during
the race. If 747 000 runners take part, how many litres of water are provided?

**i)** The exchange rate in Turkey is £1 = 2 670 000 Turkish Lira. Stephen is going on an Adriatic
cruise and changes £700 into Turkish Lira. How much will he get in Lira?

**5.** The distance between the earth and mars is on average approximately $1 \cdot 65 \times 10^8$ miles.

A spaceship has been designed to travel between the earth and mars at an average speed of 20 000 miles per hour.

How many days will the spaceship take to reach mars?
**Give your answer correct to the nearest day.**
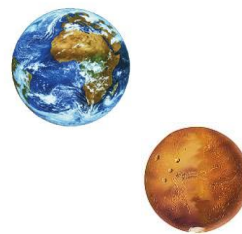
**6.** Uranium is a radioactive isotope which has a half-life of $4 \cdot 5 \times 10^9$ years. This means that only half of the original mass will be radioactive after $4 \cdot 5 \times 10^9$ years.

How long will it take for the radioactivity of a piece of Uranium to reduce to **one eighth** of its original level? Give your answer in **scientific notation**.

**7.** The population of Scotland in June 2001 was $5.06 \times 10^6$ people.

The population of China in June 2001was approximately 250 times larger than that of Scotland .

Calculate, correct to three significant figures, the population of China in 2001, expressing your answer in standard form.

**8.** The Blackbird is a two-seater high speed jet.

In December 1964 it broke a world speed record by travelling at $1 \cdot 02 \times 10^4$ metres per second.

Calculate, correct to three significant figures, the distance travelled if the jet were to maintain this speed for one hour. Express your answer in scientific notation.

*Answers*

## *Exercise 1*

**1.** **a)** The speed of light is 300 000 000 metres per second.

**b)** The diameter of the earth is 12 680 kilometres.

**c)** A Building Society has £2 150 000 000 in its funds.

**d)** The radius of the orbit of an electron is 0·000 000 05 mm.

**e)** A space probe reached a speed of 149 000 m.p.h.

**f)** The earth weighs 6 600 000 000 000 000 000 000 tonnes.

**g)** A film of oil is 0·000 000 08 mm thick.

**2.** **a)** $8·8 \times 10^{11}$    **(b)** $6·93 \times 10^{15}$    **(c)** $4·14 \times 10^{7}$    **(d)** $1·365 \times 10^{19}$

**e)** $6·86 \times 10^{24}$    **(f)** $5·52 \times 10^{12}$    **(g)** $1·19 \times 10^{7}$    **(h)** $6·24 \times 10$

**i)** $6·351 \times 10^{-4}$    **(j)** $9·09 \times 10^{-38}$    **(k)** $5·5 \times 10^{6}$    **(l)** $6·3 \times 10^{-10}$

**m)** $7·5 \times 10^{15}$    **(n)** $9·3 \times 10^{5}$    **(o)** $1·3 \times 10^{7}$    **(p)** $2·5 \times 10^{12}$

**q)** $1·7 \times 10^{-9}$    **(r)** $1·4 \times 10^{-33}$    **(s)** $8·9 \times 10^{8}$    **(t)** $1·05 \times 10^{19}$

**u)** $3·2 \times 10^{4}$    **(v)** $1·39 \times 10^{5}$    **(w)** $9 \times 10^{-6}$

**3.** **a)** $6·66 \times 10^{8}$    **(b)** $4·0506 \times 10^{4}$    **(c)** $2·94336 \times 10^{9}$

**d)** $2 \times 10^{7}$    **(e)** $3 \times 10^{30}$

**4.** **a)** $8·7 \times 10^{-1}$ grams.    **(b)** $2·52 \times 10^{7}$    **(c)** $1·943 \times 10^{8}$    **(d)** $1·794 \times 10^{10}$

**e)** £$2·016 \times 10^{7}$    **(f)** £$1·896 \times 10^{6}$    **(g)** $2·592 \times 10^{6}$    **(h)** $5·229 \times 10^{6}$

**i)** $1·869 \times 10^{9}$

**5.** 344 days

**6.** $1·35 \times 10^{10}$ years

**7.** $1·27 \times 10^{9}$

**8.** $3·672 \times 10^{7}$