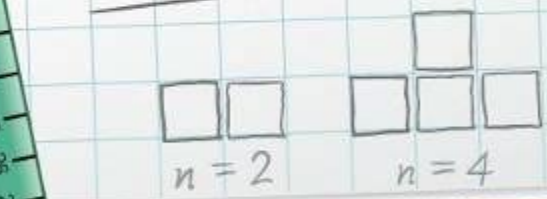
Scientific notation

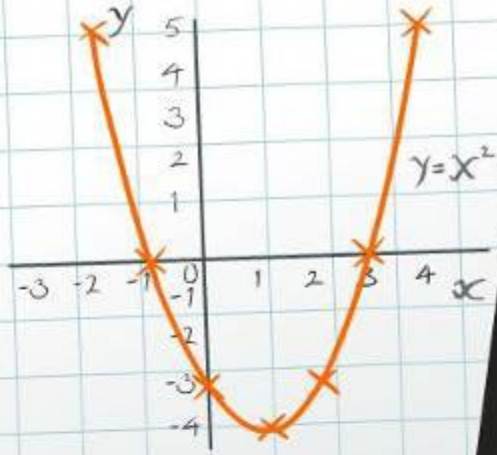
x	-2	-1	0	1	2	3	4
y	5	0	-3	-4	-3	0	5

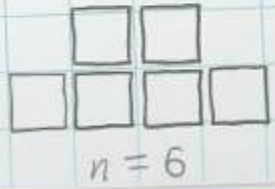
$x^2 - 2x - 3 = 0$

$(x+1)(x-3) = 0$

$x = -1$ or $x = 3$







Information

Common core icons

This icon indicates a slide where the Standards for Mathematical Practice are being developed. Details of these are given in the Notes field.

Slides containing examples of mathematical modeling are marked with this stamp.

This icon indicates an opportunity for discussion or group work.

The **Standards for Mathematical Practice** outlined in the Common Core State Standards for Mathematics describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

They are:

1) Make sense of problems and persevere in solving them.

2) Reason abstractly and quantitatively.

3) Construct viable arguments and critique the reasoning of others.

4) Model with mathematics.

5) Use appropriate tools strategically.

6) Attend to precision.

7) Look for and make use of structure.

8) Look for and express regularity in repeated reasoning.

This icon indicates that the slide contains activities created in Flash. These activities are not editable.

This icon indicates teacher's notes in the Notes field.

Powers of ten

Our decimal number system is based on **powers of ten**.

We can write powers of ten using **exponent notation**:

$10 = 10^1$
$100 = 10 \times 10 = 10^2$
$1000 = 10 \times 10 \times 10 = 10^3$
$10{,}000 = 10 \times 10 \times 10 \times 10 = 10^4$
$100{,}000 = 10 \times 10 \times 10 \times 10 \times 10 = 10^5$
$1{,}000{,}000 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^6$, etc.

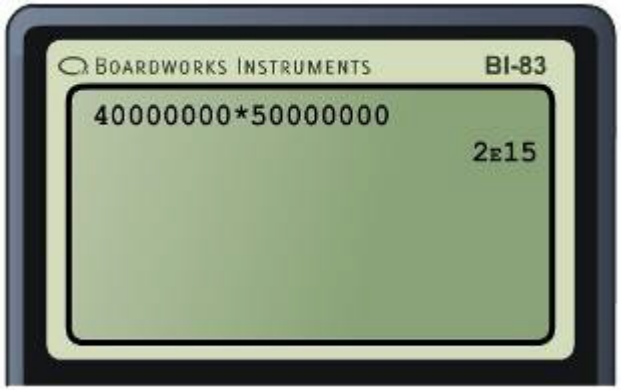
Any nonzero number raised to the power of 0 is 1, so:

Back to top

Very large numbers

Use your calculator to find the answer to the calculation 40,000,000 × 50,000,000.

Your calculator may display the answer like this:



What does the 15 mean?

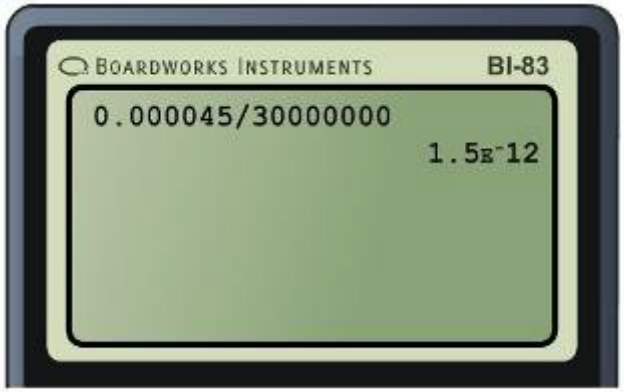
The 15 means that the 2 is multiplied 15 times by 10.

$$2 \times 10^{15} = 2{,}000{,}000{,}000{,}000{,}000$$

Very small numbers

Use your calculator to find the answer to the calculation 0.000045 ÷ 30,000,000.

Your calculator may display the answer like this:



What does the –12 mean?

The –12 means that the 15 is **divided** 12 times by 10.

$$1.5 \times 10^{-12} = 0.000000000015$$

Scientific notation

2×10^{15} and 1.5×10^{-12} are examples of numbers written in **scientific notation**.

Numbers written in scientific notation have two parts:

A number between 1 and 10 × A power of 10

This way of writing a number is also called the **standard exponent form**.

Any number can be written using scientific notation, however it is usually used to write very large or very small numbers.

Writing large numbers

We can write very large numbers using powers of ten.

The mass of the planet earth is about 5,970,000,000,000,000,000,000,000 kg.

We can write this in scientific notation as a number between 1 and 10 multiplied by a power of 10.

$$5.97 \times 10^{24}\ \text{kg}$$

A number between 1 and 10

A power of ten

Writing large numbers

How do we write these numbers in scientific notation?

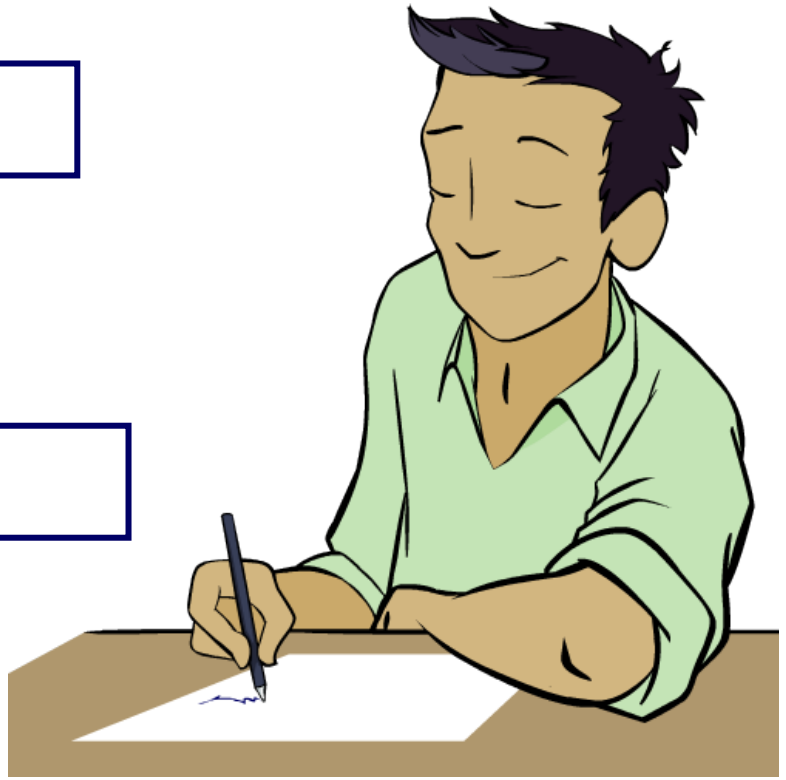
80,000,000 = 8×10^7

230,000,000 = 2.3×10^8

724,000 = 7.24×10^5

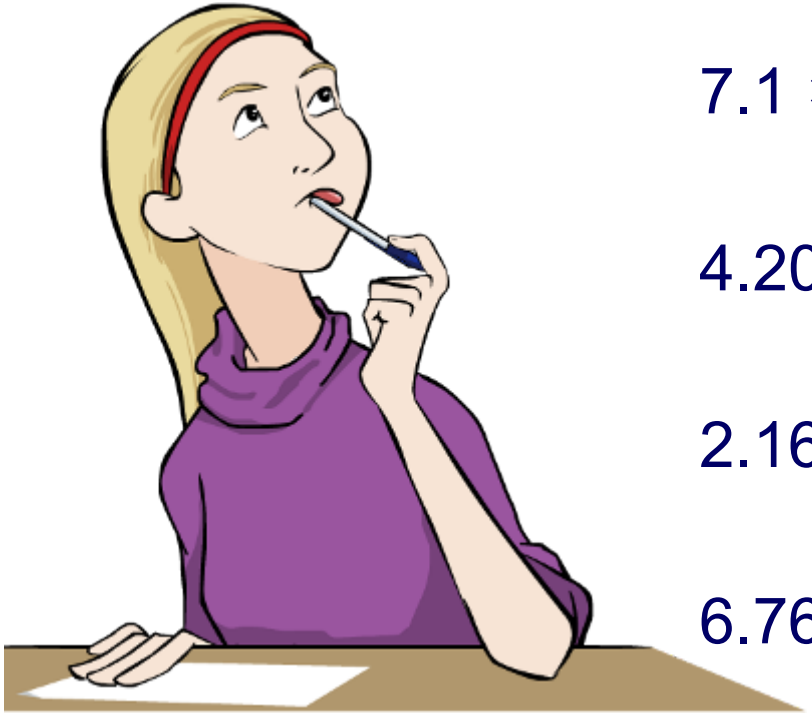
6,003,000,000 = 6.003×10^9

371.45 = 3.7145×10^2



Writing large numbers

These numbers are written in scientific notation. How can they be written as ordinary numbers?



$5 \times 10^{10} =$ **50,000,000,000**

$7.1 \times 10^{6} =$ **7,100,000**

$4.208 \times 10^{11} =$ **420,800,000,000**

$2.168 \times 10^{7} =$ **21,680,000**

$6.7645 \times 10^{3} =$ **6764.5**

Writing small numbers

We can write very small numbers using **negative powers** of ten.

For example, the width of this shelled amoeba is 0.00013 m.

We write this in scientific notation as:

$$1.3 \times 10^{-4}\ \text{m}.$$

A number between 1 and 10

A negative power of 10

Writing small numbers

How can we write these numbers in scientific notation?

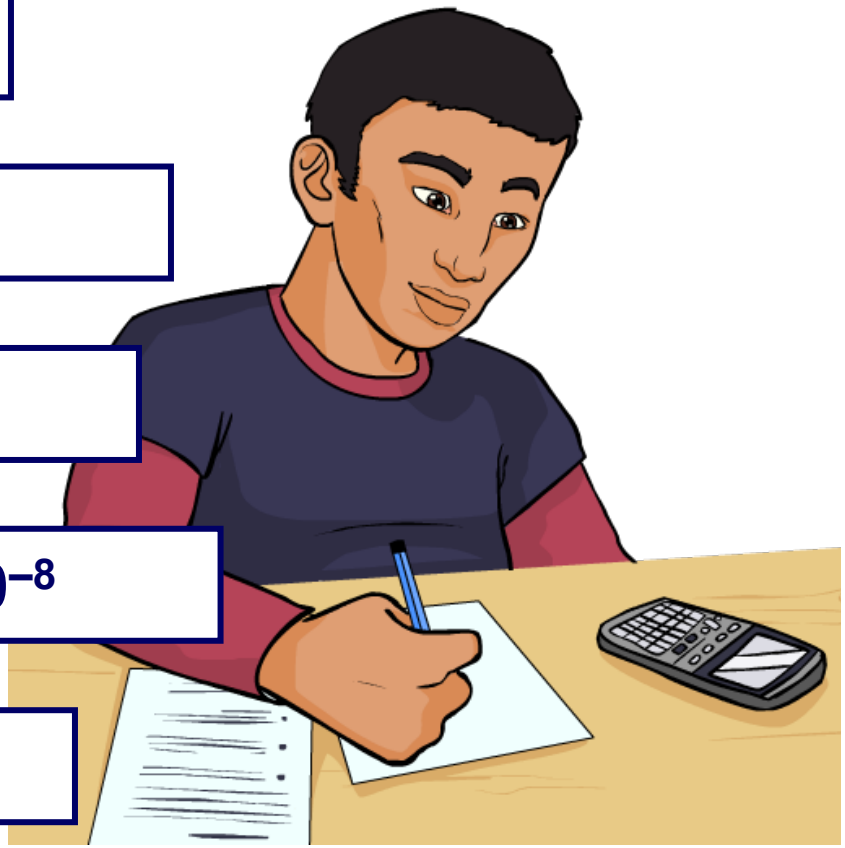
0.0006 = 6×10^{-4}

0.00000072 = 7.2×10^{-7}

0.0000502 = 5.02×10^{-5}

0.0000000329 = 3.29×10^{-8}

0.001008 = 1.008×10^{-3}



Writing small numbers

These numbers are written in scientific notation. How can they be written as ordinary numbers?

$8 \times 10^{-4} =$ **0.0008**

$2.6 \times 10^{-6} =$ **0.0000026**

$9.108 \times 10^{-8} =$ **0.00000009108**

$7.329 \times 10^{-5} =$ **0.00007329**

$8.4542 \times 10^{-2} =$ **0.084542**

Scientific notation matching

81 000	8.1×10^{-4}
8 100 000 000	8.1×10^{-6}
0.081	8.1×10^{8}
810 000	8.1×10^{5}
0.00081	8.1×10^{9}
810 000 000	8.1×10^{-9}
0.0000081	8.1×10^{4}
0.0000000081	8.1×10^{-2}

Which number is incorrect?

Which of these numbers is not in scientific notation?

0.221×10^{10}

2.7×10^{-2}

9.38×10^{5}

5×10^{-3}




Ordering numbers in scientific notation

Write these numbers in order from smallest to largest:
5.3×10^{-4}, 6.8×10^{-5}, 4.7×10^{-3}, 1.5×10^{-4}.

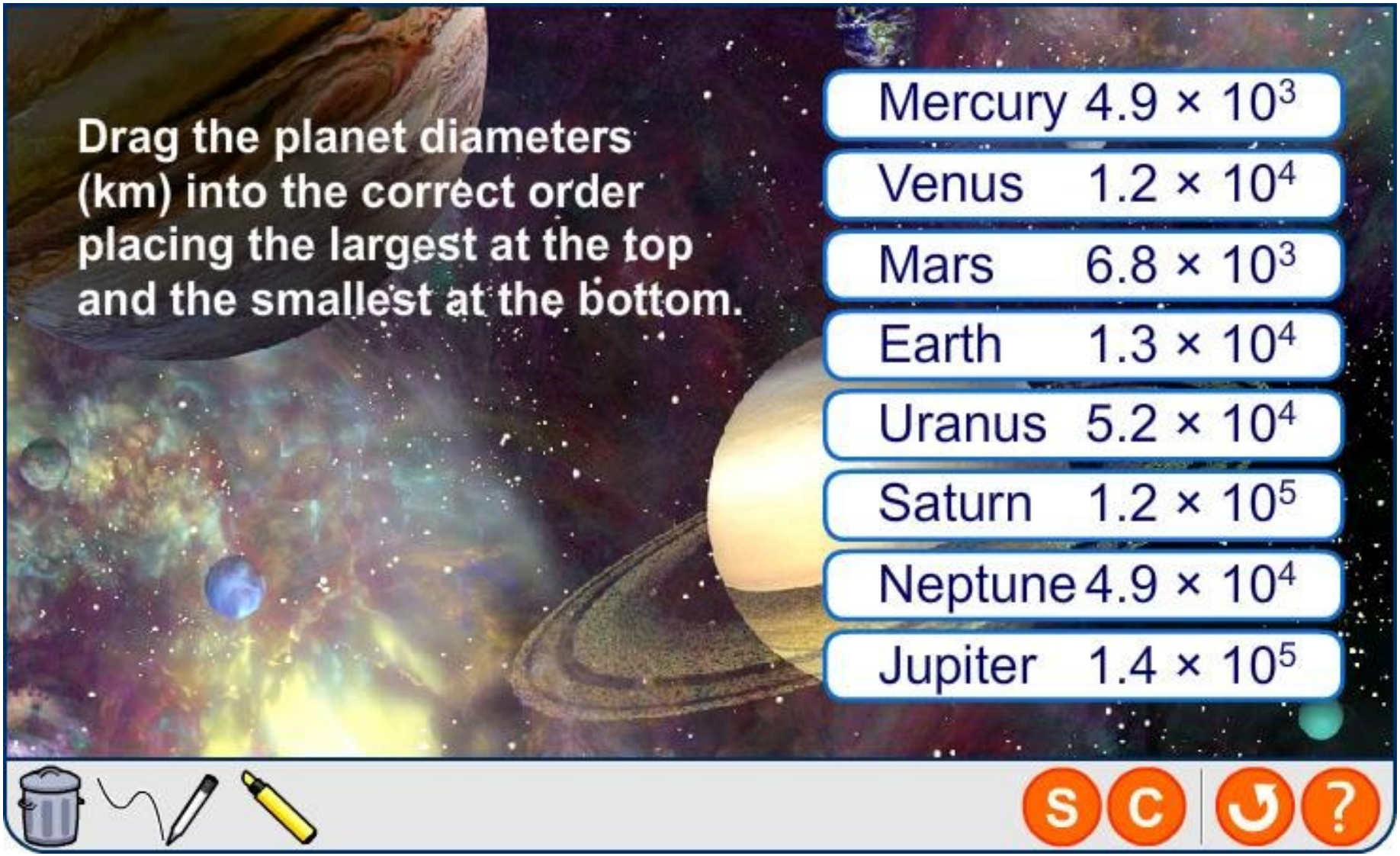
To order numbers written in scientific notation, first compare the powers of 10.

Remember, 10^{-5} is smaller than 10^{-4}, so 6.8×10^{-5} is the smallest number in the list.

When two or more numbers have the same power of ten we can compare the number parts. 5.3×10^{-4} is larger than 1.5×10^{-4} so the correct order is:

6.8×10^{-5}, 1.5×10^{-4}, 5.3×10^{-4}, 4.7×10^{-3}

Ordering planet sizes



Ordering elements

Here are the atomic radii (in meters) of some elements. Put them in the correct order with the largest at the top and the smallest at the bottom.

- Helium 4.9×10^{-11}
- Silver 1.75×10^{-10}
- Gold 1.79×10^{-10}
- Titanium 2×10^{-10}
- Oxygen 6.5×10^{-11}
- Nitrogen 7.5×10^{-11}
- Carbon 9.1×10^{-11}
- Copper 1.57×10^{-10}

C S ?

Calculations involving scientific notation

Addition	Subtraction	Multiplication	Division

Press the type of calculation to find out more about which methods to use when working with numbers in scientific notation.

Scientific notation calculations

Question: 1/5

Solve and answer in scientific notation: $(2.3 \times 10^{12}) \times (3 \times 10^{14})$

6.9×10^{168}	6.9×10^{26}
6.9×10^{-2}	6.9×10^{10}

Click the "=" button to show the working step by step.

Space ship's speed

How long would it take a space ship traveling at an average speed of 2.6×10^3 km/h to reach Mars 8.32×10^7 km away?

Rearrange speed = $\frac{\text{distance}}{\text{time}}$ to give time = $\frac{\text{distance}}{\text{speed}}$

Time to reach Mars = $\frac{8.32 \times 10^7}{2.6 \times 10^3}$

$= (8.32 \div 2.6) \times (10^7 \div 10^3)$

$= 3.2 \times 10^4$ hours

How many years?

It would take the space ship 3.2×10^4 hours to reach Mars. How long is this in years? Use your calculator

Enter $3.2 \times 10^4 \div 24$ into your calculator to give the equivalent number of days.

Divide by 365 to give the equivalent number of years.

$$3.2 \times 10^4 = 32{,}000$$
$$32{,}000 \div 24 = 1333.33..$$
$$1333.33.. \div 365 \approx 3.65$$

3.2×10^4 hours is over **3½ years**!

Now figure out approximately how old you are in minutes! Write it using scientific notation.

Atoms and molecules

The table shows some masses of very small items.

Which weighs more…

3.56×10^{20} Hydrogen atoms or 4.3×10^{19} water molecules?

5 million small grains of sand or 200 large grains?

How many atoms of silver are needed to have the same weight as a 1 Euro coin?

Item	Mass
Hydrogen atom	1.67×10^{-27} kg
Water molecule	2.99×10^{-26} kg
Silver atom	1.79×10^{-25} kg
Lead atom	3.45×10^{-25} kg
Small grain of sand	3.5×10^{-10} kg
Large grain of sand	1.1×10^{-5} kg
1 euro coin	0.008 kg

A mole of a substance is 6.02×10^{23} atoms or molecules of that substance. What does a mole of hydrogen, water, silver and lead weigh?