1 Number and algebra

Activity: Large numbers (Teacher version)

Questions

1 Fill in the following chart showing the meaning of each SI prefix for length. It may be easier to start from the base and work your way up and down.

SI prefix name	Symbol	Fractional/numerical value	Value using scientific notation
tera	T	1 000 000 000 000 = 1 trillion	1×10^{12}
giga	G	1 000 000 000 = 1 billion	1×10^{9}
mega	M	1 000 000 = 1 million	1×10^{6}
kilo	k	1000 = 1 thousand	1×10^{3}
BASE	Just the base unit (e.g. metres)	One	$1 \times 10^{0} = 1$
milli	m	$\frac{1}{1000}$ = One thousandth	1×10^{-3}
micro	μ	$\frac{1}{1\,000\,000}$ = 1 millionth	1×10^{-6}
nano	n	$\frac{1}{1\,000\,000\,000}$ = 1 billionth	1×10^{-9}
pico	p	$\frac{1}{1\,000\,000\,000\,000}$ = 1 trillionth	1×10^{-12}
femto	f	$\frac{1}{1\,000\,000\,000\,000\,000}$ = 1 quadrillionth	1×10^{-15}

2 Which two important prefixes are missing from the above table? How would you write these in scientific notation? centi (c) and deci (d)

3 Express each of these numbers in scientific notation.

a 42 000 4.2×10^{4}

b 0.000 87 8.7×10^{-4}

c 150.64 1.5064×10^{2}

d 56 789 5.6789×10^4

e 0.009 47 9.47×10^{-3}

f 5.2 Mg (in grams) 5.2×10^6 g

g 312 mm (in metres) 3.12×10^{-1} m

h 5.6 Gb (in bytes) 5.6×10^9 bytes

i 0.4 TW (in watts) 4×10^{11} watts

j 73 nm (in metres) 7.3×10^{-8} m

4 Express each of these numbers in standard numerical form.

a 4.36×10^5 436 000

b 8×10^4 80 000

c 5.967×10^{10} 59 670 000 000

d 1.482×10^{-6} 0.000 001 482

e 7.64×10^{-3} 0.007 64

f 5.3 Mg (in grams) 5 30 000 g

g 312 mm (in metres) 0. 312 m

h 5.6 Gb in (in bytes) 5 600 000 000 bytes

i 0.4 TW (in watts) 400 000 000 000 watts

j 73 nm (in metres) 0.000 000 073 m

5 Perform the indicated operations and express each answer in proper scientific notation WITHOUT using a calculator.

a $7 \times 10^6 + 2 \times 10^6$ 9×10^6

b $7 \times 10^6 - 2 \times 10^6$ 5×10^6

c $(7 \times 10^6)(2 \times 10^6)$ 1.4×10^{13}

d $(7 \times 10^6) \div (2 \times 10^6)$ 3.5

e $7 \times 10^6 - 2 \times 10^5$ 6.8×10^6

f $7 \times 10^5 + 2 \times 10^6$ 2.7×10^6

g $(7 \times 10^6)(2 \times 10^5)$ 1.4×10^{12}

h $(7 \times 10^6) \div (2 \times 10^5)$ 35

i $(7 \times 10^5) \div (2 \times 10^6)$ 0.35

6 Evaluate the following WITHOUT using a calculator.

$\frac{(3\times10^4)^2(5\times10^3)}{(2\times10^5)^2} + 7$ 119.5

7 Estimate the following WITHOUT using a calculator.

a $\frac{3.37\times10^{-4}}{(0.55)(0.0032)^2}$ $\approx \frac{3\times10^{-4}}{(5\times10^{-1})(3\times10^{-3})^2} = 66.66\ldots$

b $\frac{2}{5}(5.98 \times 10^{24})(6{,}370{,}000^2)\frac{2\pi}{8.64\times10^4}$

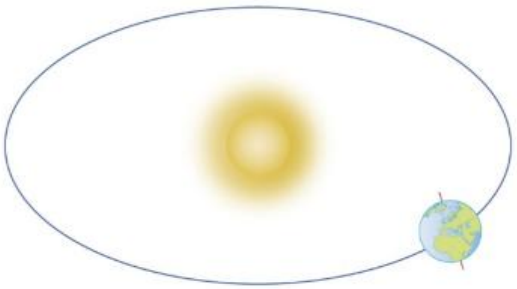
$\approx (4 \times 10^{-1})(6 \times 10^{24})(6 \times 10^6)^2 \frac{6}{9\times10^4} = 5.76 \times 10^{33}$

8 Check your answers to question 7, **using scientific notation** on your calculator, and round your final answers to 3 significant figures. What is the percentage error of each of your estimates?

a Actual = 59.8
% error = 11.4%

b Actual = 7.06×10^{33}
% error = 18.4%

9 Ride around the Sun!



The period of one revolution around the Sun is referred to as a year, or 365 days 5 hours 48 minutes and 46 seconds

You decide to ride a spaceship around the Sun following the same path as the Earth. Given that the distance from the Earth to the Sun is approximately 150 000 000 km and your spaceship travels as fast as a bicycle (approximately 20 km h^{-1}), how many hours will it take you to ride around the Sun? How many times faster is the Earth than you are?

Using the formula 'distance = speed × time', with distance being the circumference of the Earth.

Time = $15\pi \times 10^6$ hours
= 5380 years

The Earth takes 1 year to travel around the Sun – so it travels 5380 times faster than you.

10 Speed of light

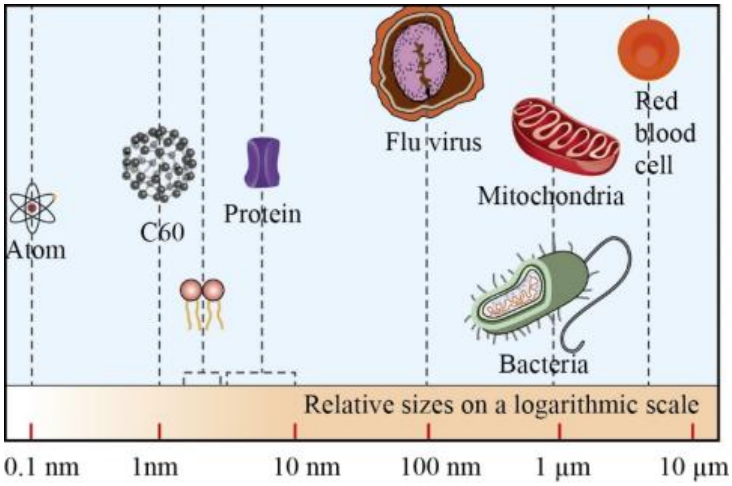
Given that light travels at approximately 3×10^8 m s^{-1} and the Earth has an approximate radius of 6.37×10^6 metres, how many times would light travel around the Earth in 1 second? How long would it take you to ride your bicycle around the Earth, assuming you ride at 20 km h^{-1}?

Distance around Earth = 4×10^7 m

How many times for light? $\frac{3\times10^8}{4\times10^7} = 0.75 \times 10^1 = 7.5$ times in 1 second.

By bicycle: $\frac{4\times10^7}{20} = 2 \times 10^3$ hours = 2000 hours

11 Viruses and bacteria



How much larger are bacteria than viruses? 10 times bigger

12 Measure and then calculate the thickness of a piece of paper. State your final answer in millimetres, metres and micrometres.

13 Research a really large or small number to present to the class. See if the class can guess what it represents.

14 Approximately 90% of the cells in your body are bacteria. Use the diagram to estimate how many kilograms of bacteria cells there are in your body.

15 According to Newton's law of gravitation, the gravitational force between two objects is directly proportional to the masses of the objects and inversely proportional to the distance between their centres of mass.

a Explain what this means.

As m_1 and m_2 increase, the force increases. As r^2 increases, the force decreases.

The equation for the gravitational force of attraction is $F = G\frac{m_1 m_2}{r^2}$, where F is the gravitational force of attraction (in newtons), m_1 and m_2 are the masses of the two objects (in kg), r is the distance between the two objects' centres of masses (in metres) and G is the universal gravitational constant (6.67×10^{-11}).

b What is the gravitational force of attraction between you and your friend?

Assuming distance is 1 metre, and students weigh approximately 50 kg each:

$F = \frac{6.67\times10^{-11}(50\text{ kg})(50\text{ kg})}{1^2} = 1.67 \times 10^{-7}$ N

c Given that the radius of the Earth is 6 370 km, use your mass (in kg) and weight $W = mg$ (in newtons) to calculate the mass of the Earth.

Assume $g \approx 10$

$W = mg = 50(10) = 500$ N

$6\,370$ km $= 6.37 \times 10^6$ m

$500 = \frac{(6.67\times10^{-11})(50)m}{(6.37\times10^6)^2}$

$m = 6.08 \times 10^{24}$ kg