Decimal Places

Most of the numbers we use in science, are not likely to be **whole numbers**. This means they will have decimal places.

For example:

If we say a car travels at a speed of 5.2 m/s. The value '5.2' has a decimal place, so it is not a whole number.

Most of our calculations in science produce values with so many decimal places we need to 'shorten' the number.

For example:

The value we know as π = 3.141592654….. and carries on forever!

We normally write π = 3.14. This is called 'rounding'.

There are two steps to follow when rounding decimal places.

Step 1: Decide how many decimal places you want in your final answer.

Step 2: Decide the value of the last decimal place by either 'rounding up' or 'rounding down', as shown below.

Example 1: Rounding π to 6 decimal places:

a. π = 3.141592654. Here '2' is in the sixth decimal place.
b. The next value to the right is '6'. A value of '5' or more means we 'round up' our value of '2' to a value of '3', as shown below.

c. π = 3.141593 (to 6 decimal places).

Example 2: Rounding π to 1 decimal place:

a. π = 3.141592654. Here '1' is in the first decimal place.
b. The next value to the right is '4'. A value less than '5' means we 'round down' our decimal place. The value '1', stays as '1'.

c. π = 3.1 (to 1 decimal place).

Exam tips!

- When doing a calculation, write down and use the all the digits shown by your calculator without rounding them.
- Write down all working; it can get marks even if your final answer is not correct.

Decimal Places: Checking understanding

Question 1

The actual length of the red blood cell from a turtle is 20.528 μm.

Round this value to **2** decimal places.

Answer _____μm

Question 2

The table below shows the boiling points of four substances.

Complete the table by rounding each Boiling Point to **1** decimal place.

Substance	Boiling Point / °C	Boiling Point / °C (to 1 decimal place)
Propane	- 42.351	
Butane	0.147	
Pentane	36.783	
Hexane	69.326	

Question 3 (Higher Demand)

A car is travelling at a speed of 31 m/s.

The car travels 46 m between the driver seeing an emergency and starting to brake.

Calculate the driver's reaction time. Give your answer to 2 decimal places.

Use the equation: $time = \frac{distance}{speed}$

driver's reaction time = ... s

Significant Figures

Some of the values we use in science are easy to use in calculations. Others, however, can be so large or so small, that they are difficult to use. This can cause mistakes to be made.

For example

The average mass of an adult human is about 75kg.

This value would be easy to use in calculations, because it has just two numbers, '7' and '5'.

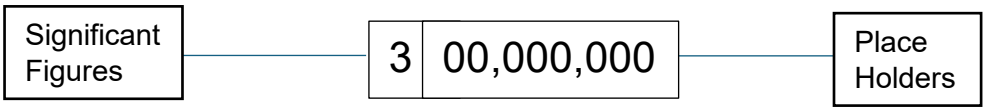
However, many of the values we use in science have so many numbers, we need to simplify them, so they are easier to use.

Simplifying Very Large Numbers

The speed of light = 299,792,458 m/s.

We normally write this value as 300,000,000 km.

This is a type of rounding called 'using significant figures'.



The **non-zero** numbers are the '**significant figures**'

The **'0's** are called '**place holders'**.

There are two steps to follow when using significant figures.

Step 1: Locate the last significant figure you want in your final answer.

Step 2: Decide the value of the last significant figure by either 'rounding up' or 'rounding down', as shown below.

Example 1: The distance from the Earth to the Sun = 149,587,985 km.
Round this value to **5 significant figures**

Step 1: Locate the 5th significant figure:

149,587,985 km

Step 2: The next number to the right has a value of '5' or more. This means we 'round up'. So, the '8' increases to '9', as shown below.

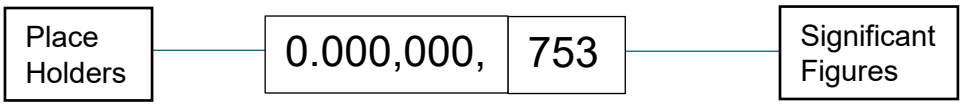
Distance from Earth to Sun = 149,5**9**0,000 km

Simplifying Very Small Numbers

The length of a virus may be = 0.000,000,752,951 m

We could round this value to 0.000,000,753 m.

For values less than '1', the place holders appear to the left of the significant figures.



The example above has 3 significant figures.

Example 2: The diameter of a Carbon atom = 0.000, 000, 000,154,375 m

Round this value to **3 significant figures**

Step 1: Locate the 3rd significant figure:

0.000,000,000,15437519 m

Step 2: The next number to the right has a value less than '5'. So, we 'round down'.

The '4' stays as '4', as shown below.

Diameter of a Carbon atom = 0.000,000,000,15**4** m

Extra Rule!

A '0' between two higher values **is a significant figure**.

For example, the distance 3**0**5,000km, the '0' between the '3' and '5' is a significant figure. This distance has been written to 3 significant figures.

Exam tips!

- When doing a calculation, write down and use the all the digits shown by your calculator without rounding them.
- Write down all working; it can get marks even if your final answer is not correct.
- If the question does not tell you how to round your answer, you should give it to 3 significant figures or more.

Significant Figures: Checking understanding

Question 1

The strength of Earths gravitational field, ‘g’ is 9.8065 N/kg.

Round this value to **2** significant figures.

Answer _____N/kg

Question 2

A learner investigating electrical resistance obtained the results below.

Complete the table by writing the values of Potential Difference (PD) to 3 significant figures.

Resistor	Current / A	PD / V	PD/ V (3 sig. fig)
A	0.25	7.651	
B	0.25	10.376	
C	0.25	6.783	
D	0.25	12.326	

Question 3 (Higher Demand)

A learner investigating photosynthesis, recorded the number of oxygen bubbles produced in one minute at different temperatures. The results are shown below.

Complete the table by calculating the bubbles produced in one second at each temperature.

Your answers must be given to **2 significant figures**.

Temperature / °C	Time / s	Number of O_2 bubbles	Rate of Photosynthesis Bubbles /s
5	60	3	
10	60	7	
15	60	16	
20	60	25	
25	60	32	

Decimal Places: Checking understanding (Answers)

Question 1

The actual length of the red blood cell from a turtle is 20.528 μm.

Round this value to **2** decimal places.

Answer = **20.53** μm

Question 2

The table below shows the boiling points of four substances.

Complete the table by rounding each Boiling Point to **1** decimal place.

Substance	Boiling Point / °C	Boiling Point / °C (to 1 decimal place)
Propane	- 42.351	**- 42.4**
Butane	0.143	**0.1**
Pentane	36.783	**36.8**
Hexane	69.326	**69.3**

Question 3 (Higher Demand)

A car is travelling at a speed of 31 m/s.

The car travels 46 m between the driver seeing an emergency and starting to brake.

Calculate the driver's reaction time. Give your answer to 2 decimal places.

Use the equation: $time = \frac{distance}{speed}$

$$time = \frac{46}{31} = 1.4839$$

driver's reaction time =……**1.48** s

Significant Figures: Checking understanding (Answers)

Question 1

The strength of Earths gravitational field, 'g' is 9.8065 N/kg.

Round this value to **2** significant figures.

Answer **9.81** N/kg

Question 2

A learner investigating electrical resistance, obtained the results below.

Complete the table by writing the values of Potential Difference (PD) to 3 significant figures.

Resistor	Current / A	PD / V	PD/ V (3 sig. fig)
A	0.25	7.651	**7.65**
B	0.25	10.376	**10.4**
C	0.25	6.783	**6.78**
D	0.25	12.326	**12.3**

Question 3 (Higher Demand)

A learner investigating photosynthesis, recorded the number of oxygen bubbles produced in one minute at different temperatures. The results are shown below.

Complete the table by calculating the bubbles produced in one second at each temperature.

Your answers must be given to 2 significant figures.

Temperature / °C	Time / s	Number of O_2 bubbles	Rate of Photosynthesis/ Bubbles per s
5	60	2	**0.033**
10	60	10	**0.17**
15	60	56	**0.93**
20	60	61	**1.0**
25	60	73	**1.2**