

Measurements in Chemistry

Significant Digits

The number of digits that we are certain of (significant digits) depend on the graduations of the measuring device

For example:

Using balance 1, the mass of the banana has been measured to _____ significant digits

Using balance 2, the mass of the banana has been measured to _____ significant digits

All calculations we perform with measured values must reflect the number of _____ (for multiplying and dividing) OR the number of _____ (for adding and subtracting) that the measured value has

Example:

2 objects are massed, one using balance 1 and the other using balance 2

Mass of object 1: 25 g

Mass of object 2: 13.45 g

The total of both masses is 38 g NOT 38.45 g

Why?

We don't know what the decimal places would have been if object 1 had been massed on balance 2 – we can't assume it was 25.00 g!

RULE #1:

When adding or subtracting measured values, the answer has the same number of **decimal places** as the least number of decimal places in the question.

Examples:

$$10.1 \text{ g} + 0.32 \text{ g} =$$

$$5.56 \text{ g} + 1.329 \text{ g} =$$

RULE #2:

When multiplying and dividing measured values, the answer has the same number of **significant digits** as the least number of significant digits in the question.

How to determine the number of significant digits a measured value has:

All non-zero digits are significant

186 has 3 significant digits; 185.89 has 5 significant digits

Zeros between non-zero digits are significant

1806 has 4 significant digits; 108006 has 6 significant digits

Any zero after a decimal point that also has significant digits before the decimal point is significant (trailing zeros)

623.0 has 4 significant digits; 6023.00 has 6 significant digits

Any zero before a decimal point and before other significant digits is not significant (leading zeros)

0.632 has 3 significant digits; 0.00632 has 3 significant digits; 0.63200 has 5 significant digits

How many significant digits?

123.4

0.023

0.00030

8120.0

804

800

Round each number to the number of significant digits indicated:

0.3261 (to 3)

679.5 (to 3)

561 (to 2)

0.00344 (to 2)

540 (to 1)

Measurements with no decimal and ending in zeros make it difficult to determine the precision of the measuring device.

For example, 1860 could be considered to have 3 or 4 significant digits depending on the precision of the measuring device

Writing the value in **scientific notation** makes it clearer: 1.860×10^3 or 1.86×10^3

****If the above example is not written in scientific notation, it will be assumed that the zero is significant**

Using RULE #2:

Answer the following to the correct number of significant digits:

$563 \times 21 =$

$45 / 56.15 =$

$0.00123 \times 0.115 =$

$0.702 \times 1.20 =$

Scientific Notation

- Measurements in chemistry generate values that range from incredibly large to incredibly small values

For example:

1 gram of iron contains about **10 000 000 000 000 000 000 000** atoms and

1 atom of iron weighs about **0.000 000 000 000 000 000 000 1** grams

- Rather than write all those zeros, scientists write these values in scientific notation
- The general form for scientific notation is $_\.__ \times 10^?$
- For numbers greater than one: move the decimal to the left until there is 1 digit in front of it. The number of places the decimal moves becomes the exponent on the 10.

15 000 000 000 000 000 000 000 =

Try: 56 000 000 =

- Your calculator can put numbers into scientific notation for you – find the button on your calculator that will do this

Using you calculator, write 923000 in scientific notation

- For numbers less than one: move the decimal to the right until there is 1 digit in front of it. The number of places the decimal moves becomes the exponent on the 10, except that now the exponent is negative.

0.000 000 000 000 000 000 000 15 =

Try: **0.000 000 45 =**