SIGNIFICANT DIGITS:

1. **Learn how to tell how many sig. digits a number has.** (It works best for scientific notation, other notation is sometimes ambiguous.)

Rules

2. **When <u>adding or subtracting</u> the last significant digit in the answer is in the same column as the least significant digit of the operands.**

   example: 3.205 + 12.70 = (write in ***columns*** …)

   ```
     3.216
   +1270?
   -------
    15916
   ```

   Answer = **15.92**

   We can see that we don't know what number to add to the 6. There is no corresponding digit in the 12.70. So, we can't write our answer as 15.916 because we don't know for sure that it is a 6. Instead we have to write **15.92** (rounding).

3. **When <u>multiplying or dividing</u> the number of significant digits in the answer is equal to the least number of significant digits in the operands.**

   example: 3.205 × 27.0 = 86.535 Answer = **86.5**
   (4) (3) ←number of significant digits.

   The lowest number of sig. digits is 3, so our answer can only have 3.
   Answer = **86.5**

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4. When doing calculations, always keep at least one extra sig. digit throughout the calculations. The determine how many sig. digits you should have in your final answer and round off to the correct number.

5. When measuring, always measure as many sig. digits as possible. Never just write 25 cm when you can write 25.3 or 25.0 cm. It is very unlikely that you will be able to measure more than 4 sig. digits.
   Labs always require sig. digits.

6. In calculations for assignments and test, I don't require sig, digits unless I specifically ask for them.
   Instead, always keep 3 or 4 digits. If you round your answer to 1 or 2 digits, you may loose important information (e.g. Is a = 6.845 greater than b = 6.801)
   Hmm ... I suppose that I should come up with a definite rule, but there seems to be no need so far.
   * The principle of always carrying an extra sig. fig. means that $\pi = 3.1416$.
   Never use $\pi = 3.14$

PRACTICE

Determine the number of significant digits in the following numbers:

1. 0.04 _____
2. 0.800 _____
3. 304 _____
4. 3800 _____
5. 6050 _____
6. 0.00300 _____
7. 0.00021 _____
8. 1.6×10^2 _____
9. 3.00×10^8 _____
10. 42.3000 _____

Write the answer with the correct number of significant digits

11. $8.4 + 1.34$ = _____
12. $9.70 - 8$ = _____
13. 8.65×2.416 = _____
14. $6.450 / 37$ = _____
15. 5.67 cm + 6.394 cm + 0.3 cm = _____
16. 5.63 cm × 33.569 cm × 23 cm = _____
17. $98.55 + 2.05 \times 0.22$ = _____
18. $0.0002 - 15 \div 45$ = _____
19. $21 / 7.0 + (4.0)^2$ = _____
20. Use reasoning and math to try and figure out how many sig. digits you would write for
    a) $\sin(88.0^\circ)$

    b) $\sin(1^\circ)$

PROBLEM
12.4 m / 1.15 s = 10.8 m/s
but
12.4 m / 1.41 s = 8.79 m/s

The lengths and times are measured to the same accuracy, but the second answer looks like it has an extra decimal place of accuracy (to 1/100 of a m/s)

Why? What is correct?

METRIC conversions.

You are expected to know these. Do the practice questions below.

→ The metric system is based on 10 and powers of 10 (normally 1000).

Anomalies: *centi- only used for metres, grams and litres.*
metres don't normally go above kilo-

Metric Prefixes: you need to know the bold **ones**

Factor	Prefix	Symbol	
10^{12}	*tera*	*T*	add zeros → move decimal right ← remove zeros move decimal left
10^{9}	**giga**	**G**	
10^{6}	**mega**	**M**	
10^{3}	**kilo**	**k**	
--	base unit --	--	
10^{-2}	**centi**	**c**	
10^{-3}	**milli**	**m**	
10^{-6}	**micro**	**μ**	
10^{-9}	**nano**	**n**	
10^{-12}	*pico*	*p*	

How to convert from one unit to another:

☺ *Method 1: Moving the decimal place.*

(i) Convert the unit to the **base unit** – by moving the decimal place right or left.
The number of decimal places to move is the exponent of the power of 10.

(ii) Then from the **base unit,** move the decimal place the correct number of places to get the desired unit.

Example 1: **32 km = ? cm**

kilo → base: move decimal place 3 to the left
32 km = 32,000 m

base → centi: move decimal place 2 to the left
32,000 m = **3,200,000 cm**

☺ *Method 2: Replace the unit with the desired unit and powers of 10*

Example 2: **0.034 μs = ? s**

$\mu = 10^{-6}$.: replace micro with 10^{-6}

$0.034\ \mu s = 0.034 \times 10^{-6}\ s = \mathbf{3.4 \times 10^{-8}\ s}$

Example 3a: **7.25×10^{-5} m = ? μm**

This is more tricky

Note: $1\ \mu m = 10^{-6}\ m$.: $1\ m = 10^{6}\ \mu m$

Replace m with 10^{6} μm

$7.25 \times 10^{-5}\ m = 7.25 \times 10^{-5} \times 10^{6}\ \mu m$

Now multiply the exponents, then multiply by 7.25

$= \mathbf{72.5\ \mu m}$

OR

Example 3b: **7.25×10^{-5} m = ? μm**

Replace m with μm, at the same time, divide by 10^{-6}

$$= \frac{7.25 \times 10^{-5}}{10^{-6}}\ \mu m \quad = 72.5\ \mu m$$

☺ *Method 3: use Zero Factor*

Metric prefix	Zero Factor	add zeros → (move decimal right) ← remove zeros (move decimal left)
Giga (G)	9	
Mega (M)	6	
Kilo (k)	3	
metre	0	
centi (c)	2	
milli (m)	3	
micro (μ)	6	
nano (n)	9	

- If both of the units that you are converting between are on the **same** side of the line, **take the difference** between the number of zeros.
- If the units are on **opposite** sides of the line, **add** the number of zeros.
- Look at the right column to see whether you move the decimal right or left

- The 'zero factor' is really the exponent without the – sign for units smaller than 1 metre. (e.g. Giga = 10^9 milli = 10^{-3})

Example 4: **How many milliseconds in 4500 microseconds?**
milli and micro are on the same side of the 'metre' line - - so 6–3 = 3 zeros.
* *There aren't 3 zeros to remove*, so move the decimal point 3 places left.
Answer: **4.5 milliseconds.**

Example 5: **Convert 3 km to cm.**
kilo and centi are on opposite sides, ∴ add 3 + 2 = 5 zeros.
Answer: **300,000 cm**

Convert 3.2 km to cm
Answer: **320,000 cm**

METRIC PRACTICE

1. How many megabytes in 25 gigabytes?
2. What is the speed of a 866 MHz computer in Hertz?
3. The distance from the sun to Pluto is 5.9 gigametres. How many km is this?
4. What is the power of a 120 W light bulb in kilowatts?
5. How many grams in ½ a kilogram? (write as a decimal, not a fraction)
6. A thin piece of metal is 2500 micrometers. How much is this in centimeters?
7. Convert 2.3456 x 10^{-5} m to nm
8. How many litres of pop in nine 350 mL cans?
9. 0.0032 m = _____ mm
10. 8.28 E-5 m = _____ nm
11. 25 nm = _____ m
12. 1600000 Hz = 1.6 __ Hz
13. 234.9876543 MW = _____ W

Read me:
3 E 15 is an old short form for writing $3x10^{15}$
7.2E-3 means 7.2 x 10^{-3} which equals 0.0072