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Units and Significant Figures Notes:

Name: Key

Scientific notation:

When calculating the number of molecules, moles, mass and volume of chemicals it will be useful to use scientific Notation.

→ To make it easier to work with very small and Large numbers.

→ To more easily show how many significant figures a measurement has.

Changing large numbers to scientific notation:

Step 1: Move the decimal to make a number between 1 and 10.

Step 2: Count how many places the decimal point moved.

Step 3Write the number without all the 0s and multiply by a power of 10. The exponent tells how many places the decimal point was moved.

Ex. 240 000. = $2.40000 \times 10^5 = 2.4 \times 10^5$

Changing very small numbers to scientific notation:

Step 1: Move the decimal point to the right to make a number between 1 and 10.

Step 2: Use a negative power of 10 to show how many places the decimal was moved.

Ex. 0.0000048 =$0000004.8 \times 10^{-6} = 4.8 \times 10^{-6}$

Changing back to standard form:

If the exponent is positive, make a larger number:

Move the decimal point to the RIGHT the number of times indicated by the exponent and then add zeros to fill the spaces.

Ex. 5.3×10^7 = 53 000 000

If the exponent is negative, make a smaller number:

Move the decimal point to the LEFT the number of times indicated by the exponent and then add zeros to fill the spaces.

Ex. 5.3×10^{-7} = 0.00000053

PRACTICE:

Express the following in Scientific notation:

1. 210 000. = 2.1×10^5
2. 0.0000012 = 1.2×10^{-6}
3. 6580 = 6.58×10^3
4. 0.023 = 2.3×10^{-2}

Express the following in standard form:

1. 1.32×10^3 = 1320
2. 2.5×10^{-6} = 0.0000025
3. 3.567×10^{-4} = 0.0003567
4. 1.10×10^8 = 110000000

SI UNITS:

The international System (SI) of metric units has numerous "base units". The following are used Chemistry 11.

Quantity	Written Unit	Unit Symbol
length	metre	m
mass	gram	g
time	second	s
Amount of substance	mole	mol
volume	litre	L

Prefixes can be placed in from of any "base unit" and represent multiples of the base unit.

Written Prefix	Prefix Symbol	Equivalent exponential	What does this mean? - grams are used as an example - any other base unit could replace (g)
mega	M	10^6	1 Mg = 10^6g (or 1000,000g)
kilo	k	10^3	1kg = 10^3g (or 1000g)
deci	d	10^{-1}	1 dg = 10^{-1}g (or 0.1g)
centi	c	10^{-2}	1 cg = 10^{-2} g (or 0.01g)
milli	m	10^{-3}	1 mg = 10^{-3}g (or 0.001g)
micro	µ	10^{-6}	1 µg =10^{-6} g (or 0.000001g)

Write conversion statements for each of the following:

1. kg and g
   1 kg = 10^3g or
   1kg = 1000 g
2. µL and L
   1 µL = 10^{-6} L
   or
   1 000 000 µL = 1 L
3. mmol and mol
   1 mmol = 10^{-3} mol
   or
   1000 mmol = 1 mol
4. Mm and m
   1 Mm = 10^6 m
   or
   1 Mm = 1000 000 m
5. cs and s
   1 cs = 10^{-2} s
   or
   100 cs = 1 s
6. dm and m
   1 dm = 10^{-1} m
   or
   10 dm = 1 m

You will need to be able to convert between units to perform calculations in Chemistry 11!!

Method #1 = Conversion factor method

Example: How many micrometers are there in 5cm?

Unknown Amount = # of µm
Initial Amount = 5 cm

You can write your own conversion statements between µm and m, and cm and m.

$1\ \mu m = 10^{-6} m$ These statements can be combined to make the connections below:
$1\ cm = 10^{-2} m$ µm → m → cm

The conversion is: $\# \text{ of } \mu m = 5cm \times \frac{10^{-2} m}{1\ cm} \times \frac{1\ \mu m}{10^{-6} m} = 5 \times 10^4\ \mu m$ (or 40000 µm)

Remember your exponent rules! $10^x / 10^y = 10^{x-y}$
$10^x \times 10^y = 10^{x+y}$

Try the unit conversion method:

1. 3s = ? ms

$$3s \times \frac{1ms}{10^{-3}s} = 3000ms \quad \text{or} \quad 3.0 \times 10^3 ms$$

2. 7 µL = ? dL

$$7\mu L \times \frac{10^{-6} L}{1\ \mu L} \times \frac{1\ dL}{10^{-1} L} = 7 \times 10^{-5} dL$$

3. 3 Mm = cm

$$3\ Mm \times \frac{10^6 m}{1\ Mm} \times \frac{1cm}{10^{-2} m} = 3 \times 10^8 cm$$

4. 3.5m/s = ? km/h

$$3.5 \frac{m}{s} \times \frac{1Km}{10^3 m} \times \frac{60s}{1min} \times \frac{60min}{1h} = 12.6 \frac{Km}{h}$$

Method #2 – Number line method

Metric Units and Conversions

Value	1,000,000	100,000	10,000	1,000	100	10	1	1/10	1/100	1/1000	1/10000	1/100000	1/1000000
Exponent	10^6	10^5	10^4	10^3	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
Prefix	mega			kilo	hecto	deka	base unit	deci	centi	milli			micro
Abbr.	M			k	h	da		d	c	m			μ

1. Find the prefix with which you are beginning. If no prefix is attached, you are beginning with a "base unit" at 10^0.
2. Find the prefix for the answer you are seeking. Ig the unit has not prefix attached, you are converting to the "base unit" at 10^0.
3. Count the number of places on the number line to get from where you are starting to where you are finishing.
4. Now, move the decimal in the number you are converting that same number of places, and in the same direction that you moved on the number line. (if you moved left three spaces, you move the decimal left three spaces to complete the conversion

TRY the number line method: Convert 0.035 decimeters (dm) into millimeters (mm)

3.5 mm

Do the following conversions. Use the method that works for you!

1. 50.0mL into Liters

   0.0500 L

2. 25 kg into grams

   25 000 g

3. 3125 μL into kiloliters

   0.000003125 kL

4. 1.6 μmol into millimoles

   0.0016 mmol

5. 1 mg/dL into grams per liter

   $\frac{1mg}{1dL} \to \frac{0.001g}{0.1L} = 0.01 g/L$

6. 5 cg/ds into milligrams per second

   $\frac{5cg}{1ds} = \frac{50mg}{0.1ds} = 500\frac{mg}{ds}$

Significant Figure = a measured or meaningful digit

Ex. Stop watch: 35.2s
Beam balance: 97.53g
Electronic balance: 97.5295g

10 Rules for recording and doing calculations with significant figures:

1. ***Trailing zeros with no decimal point*** after them are not considered significant.
   Ex. How many sig. figs do the following have?
   100 m → 1 sig.figs
   1100 km → 2 sig. figs.
   120 000 mg → 2 sig. figs.

2. ***Trailing zeros after a decimal point*** are assumed to be significant. They show the precision of the measuring device.
   Ex. How many sig. figs do the following have?
   1.20 g → 3 sig. figs.
   1.00×10^3mL → 3 sig. figs.
   321.000 µs → 6 sig. figs.

3. ***Leading zeros*** are not significant.
   Ex. How many sig. figs do the following have?
   0.00021 g → 2 sig. figs.
   0.03 mol → 1 sig. figs.
   0.120 s → 3 sig. figs.

4. ***All numbers in scientific notation*** (other that the "10^x") are significant.
   Ex. How many sig. figs. do the following have?
   1.3×10^3g → 2 sig. figs.
   1.000×10^2L → 4 sig. figs.
   2.1200×10^{-3} mmol → 5 sig. figs.

PRACTICE: Indicate how may significant figures there are in each of the following measurements.

a) 3570mm - 3 c) 41.400L - 5 e) 0.000572 g/mL - 3 g) 4.150×10^{-4} mol - 4
b) 17.505cm - 5 d) 0.51 mL - 2 f) 0.00900 g/s - 3 h) 7.160×10^5 mg - 4

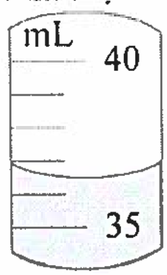
5. **Accurate measurements** = measurements close to the correct or accepted value
   Precise measurements = measurements with more significant digits

   Ex. A "calibration weight" has a mass of exactly 1.000 000g. A student uses 4 different balances to check the mass of the weight. The results of the are shown below.
   Mass using balance A = 0.999 999 g
   Mass using balance B = 1.00g
   Mass using balance C = 3.0g
   Mass using balance D = 0.811 592

   a) Which of the balances give accurate weighings? A + B
   b) Which of the balances give precise weighings? A + D
   c) Which balance is both accurate and precise? A

6. **Recording measurements**: Includes all certain digits plus the first uncertain digit. Example: read the graduated cylinder below and record the mL to the correct number of significant figures. Read at the bottom of the **meniscus**.

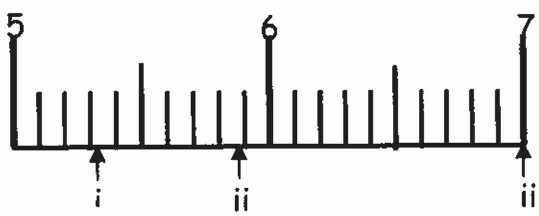
Graduated cylinder



36.5 mL

7. **"Defined" numbers and "counting numbers"** are assumed to be perfect, and so are "exempt" from the significant figure rules. They are considered infinitely significant.
   Ex. 1 book
   4 people
   1kg = 1000g

8. **When reading scales**: any calibrated divisions count as certain digits, even if there is not a number written under them. If a pointer is right at a line, add a 0 for the uncertain digit. Read the following measurements from this cm ruler:



i) 5.32 ii) 5.88 iii) 7.00

9. After **multiplying or dividing** measurements, round to the least number of significant figures in the calculations.

a) 12.5 x 0.50 = 6.3
b) 0.15 x 0.0016 = 2.4×10^{-4}
c) 40.0 x 30.0000 = 1.20×10^{3}
d) (2.5 x 7.500) / 0.15 = ~~NA~~ 130
e) $(6.40 \times 10^{8}) \times (5 \times 10^{5})$ = 3×10^{14}
f) 0.02400 / 6.000 = 4.000×10^{-3}

10. After **adding or subtracting**, round to the least number of decimal places in the calculations. (The idea behind this rule is simple. The number with the least number of decimal places is least precise and limits the precision of the final result.)

a) 15.1 + 75.32 = 90.4
b) 178.90456 – 125.8055= 53.0991
c) $(4.55 \times 10^{-5}) + (3.1 \times 10^{-5})$ = 7.7×10^{-5}
d) 0.000159 + 4.0074 = 4.0076
e) $(1.805 \times 10^{4}) + (5.89 \times 10^{2})$= 1.864×10^{4} (0.0589×10^{4})
f) 45.128 + 8.50187 – 89.18= –35.55