The “MOLE”

AND

“Molar Mass”
ATOMS ARE REALLY SMALL!!

- We can’t work with individual atoms in the LAB
- Because we can’t see things that small
So let’s count a WHOLE BUNCH all at once!
A NEW UNIT OF MEASUREMENT
THE MOLE

6.02 \times 10^{23}

- A counting unit
- Like a “dozen” but really, really big!
The Mole

Don’t need to write down what’s in the orange boxes

- Similar to a dozen, except instead of 12, it’s 602 billion trillion

602,000,000,000,000,000,000,000,000
Avogadro’s Number

Amedeo Avogadro 1776 – 1856

Decided that:

$6.02 \times 10^{23}$
molecules per mole
Just How Big is a Mole?

- Soda cans to cover the surface of the earth over 200 miles deep.
- Avogadro's number of unpopped popcorn kernels spread across the USA...over 9 miles deep.
- Count atoms at the rate of 10 million per second, it would take about 2 billion years to count the atoms in one mole.
**A Mole of “Particles”**

Particles is a generic term

<table>
<thead>
<tr>
<th>Particles</th>
<th>Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATOMS</td>
<td>1 mole C</td>
</tr>
<tr>
<td>MOLECULES</td>
<td>1 mole $\text{H}_2\text{O}$</td>
</tr>
<tr>
<td>COMPOUNDS</td>
<td>1 mole $\text{CaCl}_2$</td>
</tr>
<tr>
<td>IONS</td>
<td>$\text{NH}_4^+$</td>
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</tbody>
</table>

<p>| | |</p>
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>1 mole $\text{H}_2\text{O}$</td>
<td></td>
</tr>
<tr>
<td>1 mole molecules</td>
<td></td>
</tr>
<tr>
<td>2 moles H atoms</td>
<td></td>
</tr>
<tr>
<td>1 mole O atoms</td>
<td></td>
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</tbody>
</table>
The Mole is a Unit Song

https://www.youtube.com/watch?v=1R7Nilum2TI
COUNTING VERSUS WEIGHING!

- 1 dozen donuts = 12 donuts
- 1 mole of donuts = $6.02 \times 10^{23}$ donuts

- 1 dozen Al atoms = 12 Al atoms
- 1 mole of Al atoms = $6.02 \times 10^{23}$ atoms

The NUMBER in a mole is always the same, but the MASS is very different!
Mass of an Atom

Tiny tiny tiny!!! - Use a special unit:

Atomic mass unit = “amu”

1 amu = $1.66 \times 10^{-24}$ grams

1 atom of H = $1.66 \times 10^{-24} \text{g} =$

1 atom of C = $1.99 \times 10^{-23} \text{g} =$

1 atom of O = $2.656 \times 10^{-23} \text{g} =$
Molar Mass  How many GRAMS PER MOLE?
LOOK ON THE PERIODIC TABLE!
How much does a mole of something weigh???

1 mole of C atoms = 12.0 g
1 mole of Mg atoms = 24.3 g
1 mole of Cu atoms = 63.5 g

THE CONVERSION FACTOR VERSION!
Molar Mass of C = 12.01 g/mol
Molar Mass of Mg = 24.3 g/mol
Like saying 12 in/ft
Learning Check!

Find the molar mass

1) Br = 79.9 g/mole
2) Sn = 118.7 g/mole
Molar Mass of Molecules & compounds

Add up the mass for each part of the molecule

1 mole of \( \text{CaCl}_2 \) = 1 Ca + 2 Cl

Ca = 40.1 g/mol  Cl = 35.5 g/mol

1Ca + 2Cl =

40.1 + 35.5 + 35.5 = 111.1 g/mol
Molar Mass of Molecules & compounds

Molar Mass of $\text{N}_2\text{O}_4 = ?$

N = 14.0 g/mol    O = 16.0 g/mol

$2N + 4O =$

$(2 \times 14.0) + (4 \times 16.0) = 92 \text{ g/mol}$
Molar Mass of Molecules & compounds

Molar Mass of antacid Al(OH)₃ = ?

1Al + 3 O + 3H

Al = 27.0 g/mol  O = 16 g/mol  H = 1.0 g/mol

(1* 27.0g/mol) + (3*16.0g/mol) + (3*1.0)  = 78g/mol