the zen of chemistry

www.zenofchemistry.com

The Mole
The Basics

Presented by

Amelia McCutcheon

The mole

"A mole is defined as the amount of substance that contains the same number of specified particles as there are atoms in 12 g of carbon-12."

From Heineman Chemistry 1 (Lukins et al)

Avogadro's number (N_A):

1 mole contains 6.02×10^{23} particles

The mole

"A mole is defined as the amount of substance that contains the same number of specified particles as there are atoms in 12 g of carbon-12."

From Heineman Chemistry 1 (Lukins et al)

Avogadro's number (N_A):

1 mole contains 6.02×10^{23} particles

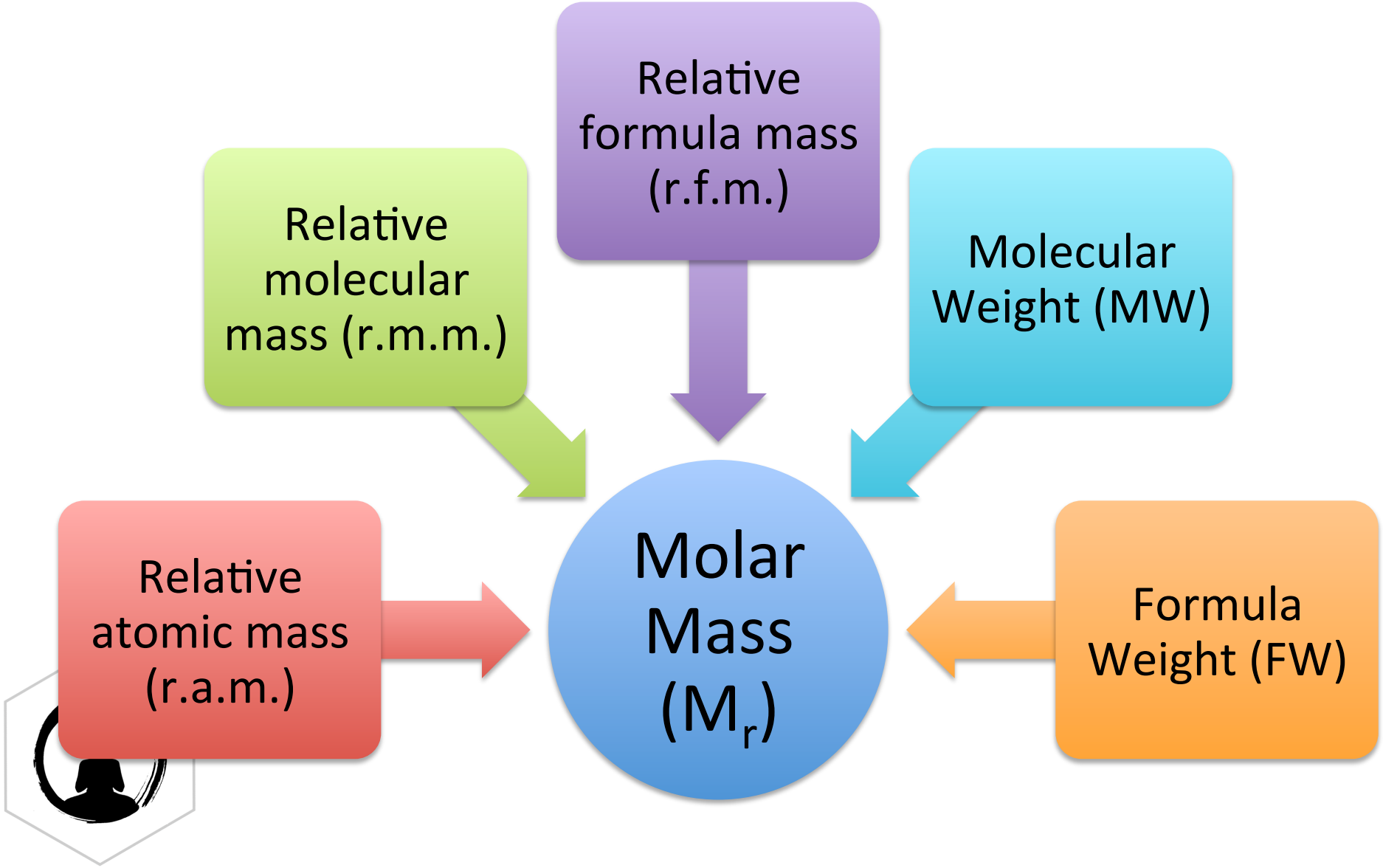
The mole

"A mole is defin… …bstance that co… …d partic… ca… …s et al)

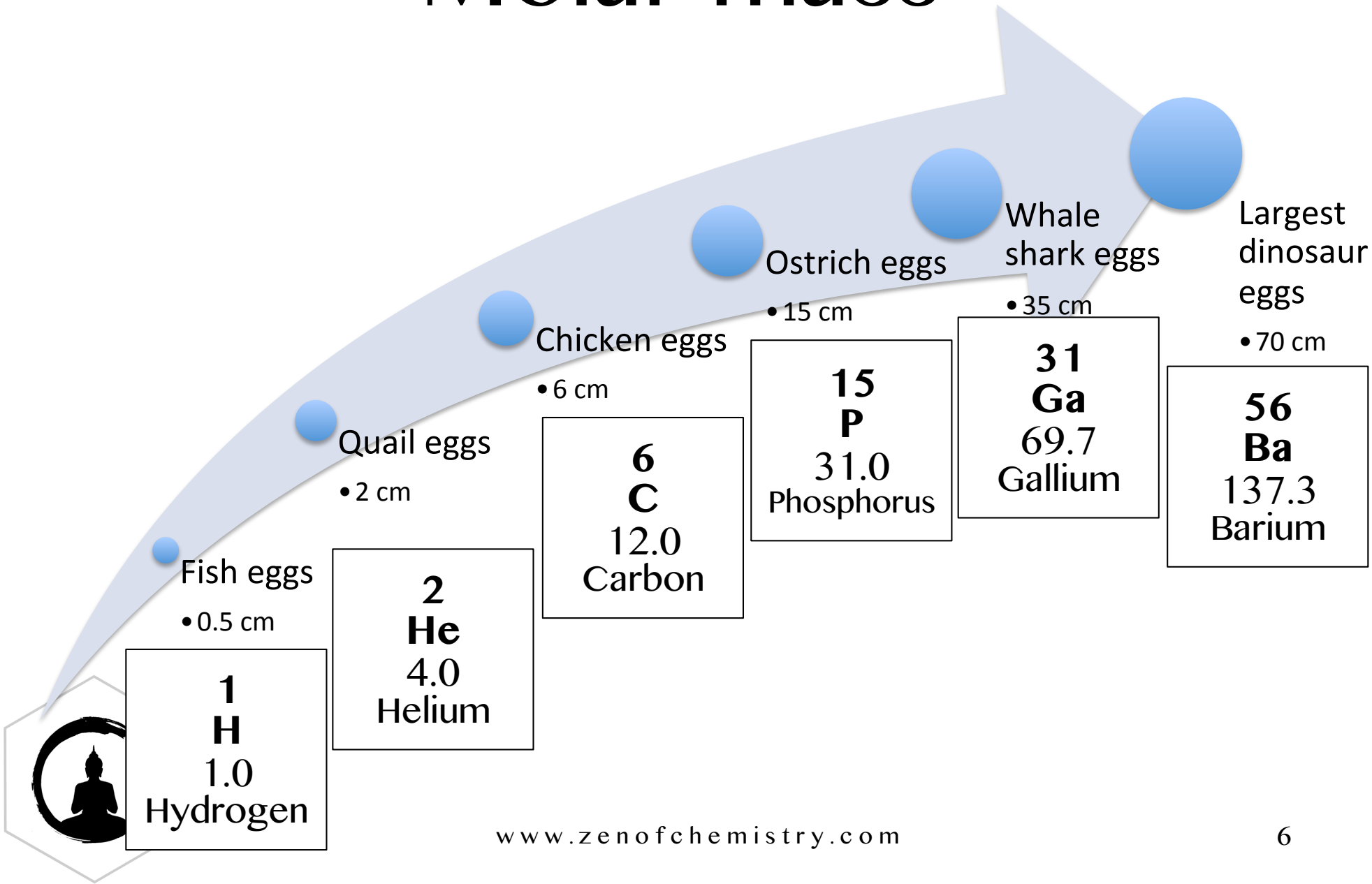
Avoga…

1 mole contains 6.02 x 10^{23} particles

Molar Mass


Relative formula mass (r.f.m.)
Relative molecular mass (r.m.m.)
Molecular Weight (MW)
Relative atomic mass (r.a.m.)
Molar Mass (M_r)
Formula Weight (FW)

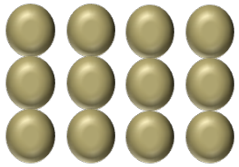
Molar mass


Fish eggs
• 0.5 cm
1
H
1.0
Hydrogen
Quail eggs
• 2 cm
2
He
4.0
Helium
Chicken eggs
• 6 cm
6
C
12.0
Carbon
Ostrich eggs
• 15 cm
15
P
31.0
Phosphorus
Whale shark eggs
• 35 cm
31
Ga
69.7
Gallium
Largest dinosaur eggs
• 70 cm
56
Ba
137.3
Barium

Egg Masses

...for the purposes of the example, let's assume that all eggs came in dozens (i.e. 12 eggs)

Egg Masses



Fish Eggs

Chicken Eggs

Dinosaur Eggs

1 dozen atoms have different masses depending on the element

1 H 1.0 Hydrogen	1 H 1.0 Hydrogen	1 H 1.0 Hydrogen
1 H 1.0 Hydrogen	1 H 1.0 Hydrogen	1 H 1.0 Hydrogen
1 H 1.0 Hydrogen	1 H 1.0 Hydrogen	1 H 1.0 Hydrogen
1 H 1.0 Hydrogen	1 H 1.0 Hydrogen	1 H 1.0 Hydrogen

mass = 12.0 units

mass = 144 units

6 C 12.0 Carbon	6 C 12.0 Carbon	6 C 12.0 Carbon
6 C 12.0 Carbon	6 C 12.0 Carbon	6 C 12.0 Carbon
6 C 12.0 Carbon	6 C 12.0 Carbon	6 C 12.0 Carbon
6 C 12.0 Carbon	6 C 12.0 Carbon	6 C 12.0 Carbon

56 Ba 137.3 Barium	56 Ba 137.3 Barium	56 Ba 137.3 Barium
56 Ba 137.3 Barium	56 Ba 137.3 Barium	56 Ba 137.3 Barium
56 Ba 137.3 Barium	56 Ba 137.3 Barium	56 Ba 137.3 Barium
56 Ba 137.3 Barium	56 Ba 137.3 Barium	56 Ba 137.3 Barium

mass = 1647.6 units

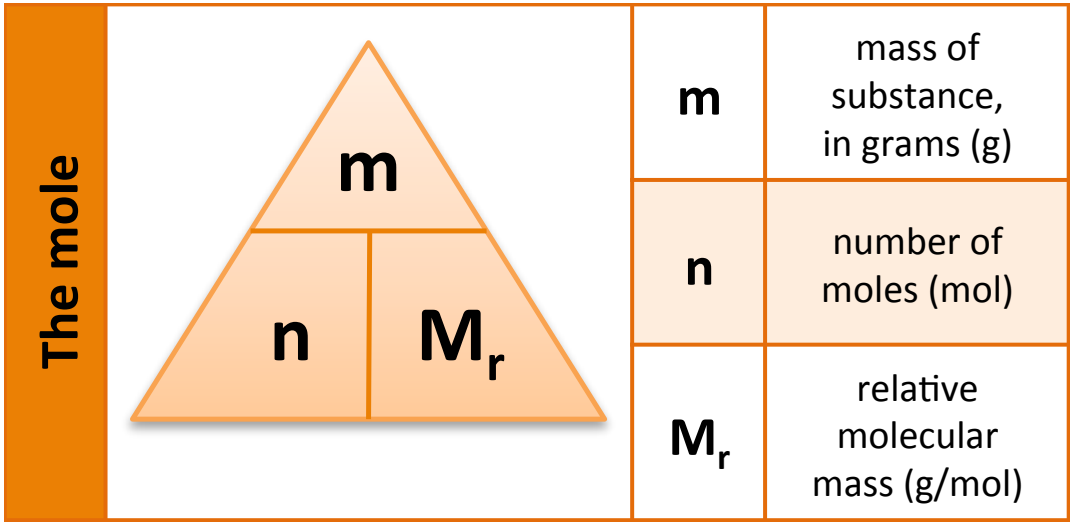
Molar Mass

- The mass of 1 mol of atoms/molecules/particles

  1 mol is NOT a dozen particles but 6.02 x 10^{23} particles!!

  602,000,000,000,000,000,000,000

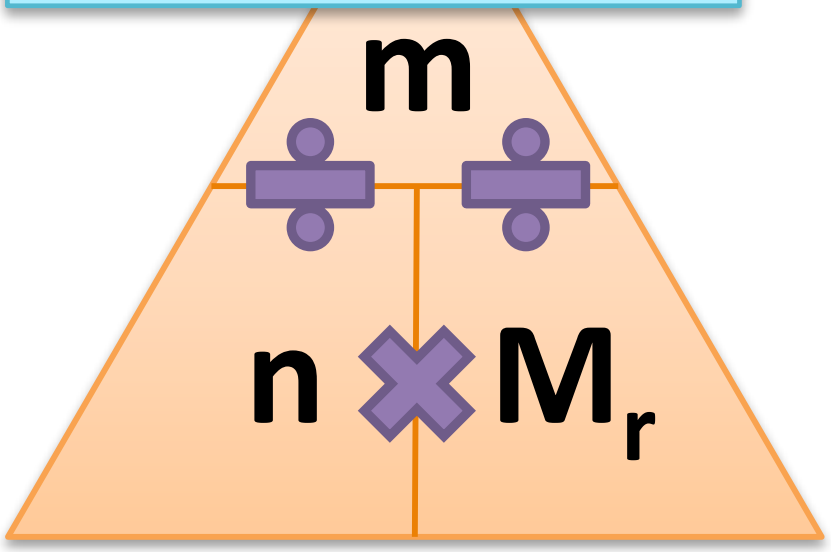
- Units: grams per mol (g/mol)



How to use equation triangles:

1. Write down the term you wish to calculate (e.g. n =).
2. Cover the term you wish to calculate with your hand.
3. What remains is your equation on the other side of the = sign, working from the top down and/or left to right, and include all multiplication/division signs linking the two remaining terms.
4. The three equations derived from this triangle are:
   - $n = m \div M_r$
   - $m = n \times M_r$
   - $M_r = m \div n$

The horizontal line corresponds to division; the vertical line corresponds to multiplication.



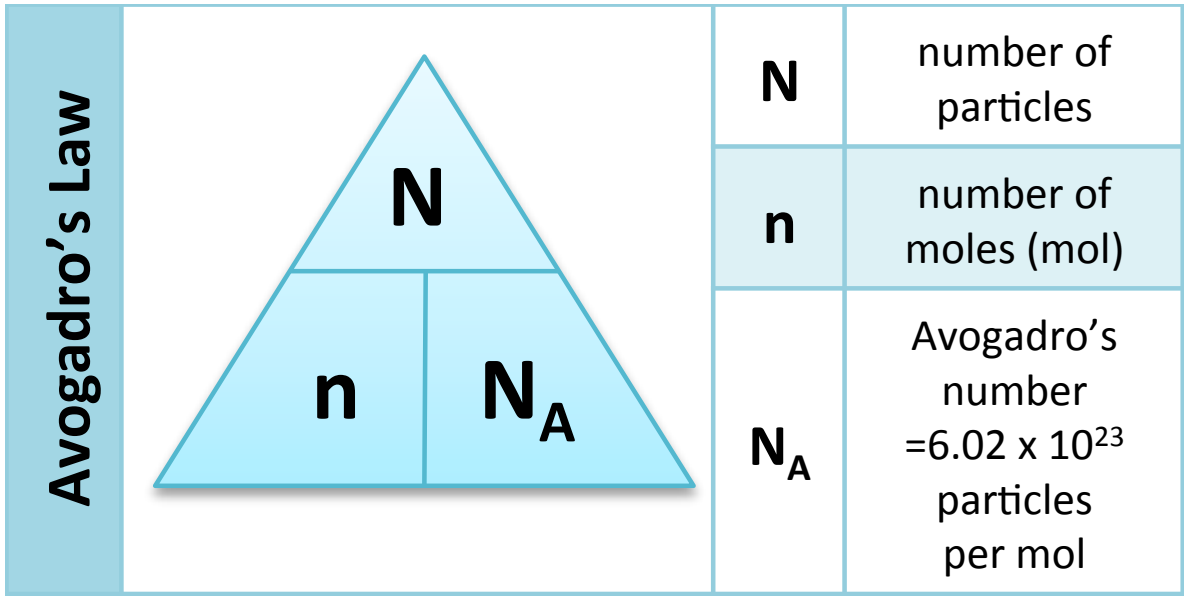
Avogadro's Number

Eggs

- 1 dozen eggs = 12 eggs
- ½ dozen eggs = 6 eggs
- 2 dozen eggs = 24 eggs
- 3 dozen eggs = 36 eggs

Moles

- 1 mole atoms = 6.02×10^{23} atoms
- ½ mole atoms = 3.01×10^{23} atoms
- 2 moles atoms = 12.04×10^{23} atoms
- 3 moles atoms = 18.06×10^{23} atoms



Empirical & Molecular Formulae

Molecular formula:

Exact number of atoms in a molecule

e.g. Ethane: C_2H_6

M = 30 g/mol

e.g. glucose: $C_6H_{12}O_6$

M = 180 g/mol

Empirical formula:

Lowest whole number ratio of atoms in a molecule

e.g. Ethane: CH_3

M = 15 g/mol

e.g. glucose: CH_2O

M = 30 g/mol

Percentage by mass

$$\% \text{ by mass} = \frac{\text{mass of one component}}{\text{mass of the total}} \times 100\%$$

This can be used for:

- % w/w
- % yield
- % by mass of one element in a compound
- % by mass of water

the zen of chemistry

www.zenofchemistry.com

The Mole
The Basics

Presented by

Amelia McCutcheon