Chapter 2.4 Chemical Formulas

Different Representations

Chemical Formulas

NH_3 ammonia

1 atom of Nitrogen
3 atoms of Hydrogen

N_1H_3 only include Subscript > 1

Not NH3 Correct NH_3 ↓ subscript

CH_4 → 1 Carbon & 4 Hydrogens

NaC_2H_5O → 1 Sodium, 2 Carbon, 5 Hydrogen, 1 Oxygen

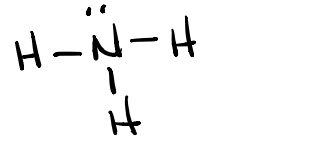
Subscripts are ratios, Fixed ratios ratios are atom ratios or molar ratios

Other representations

Molecular Formula → Lewis Structure → 3D Structure

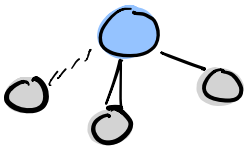
NH_3

# of atom in ratios



How atoms are connected

- How to build them comes later
- Know how to read them



C N O H X

Cl Br I F

Chemical Formula — Atom ratios & some structural info

Lewis Structures — Atom Connectivity which atoms are connected to which

3D molecules — Shape

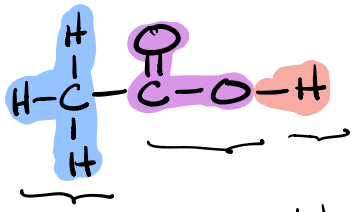
Examples of formulas

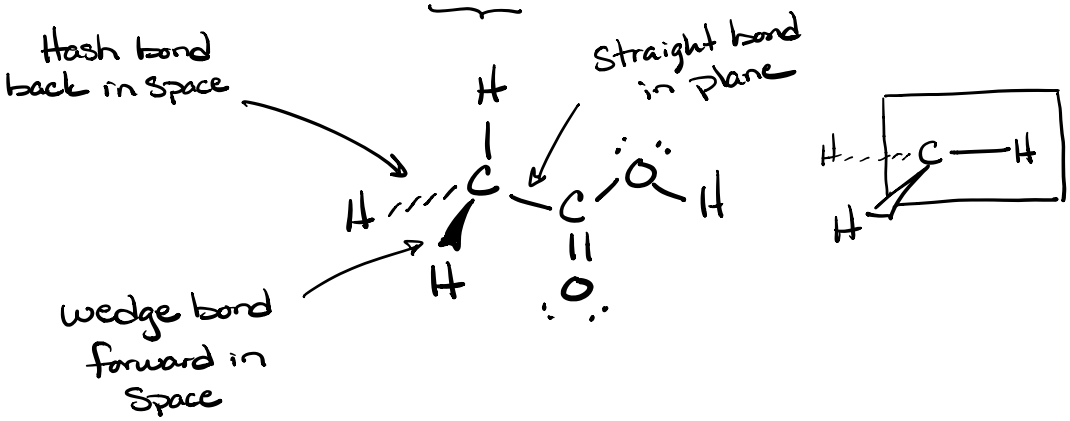
$C_2H_4O_2$ Simple molecular formula

CH_3COOH

CH_3CO_2H

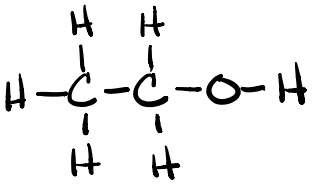
molecular formula that has some structure encoded





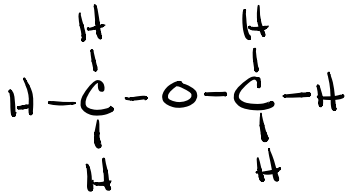
Molecular Formulas can have defferent molecules they represent

C_2H_6O



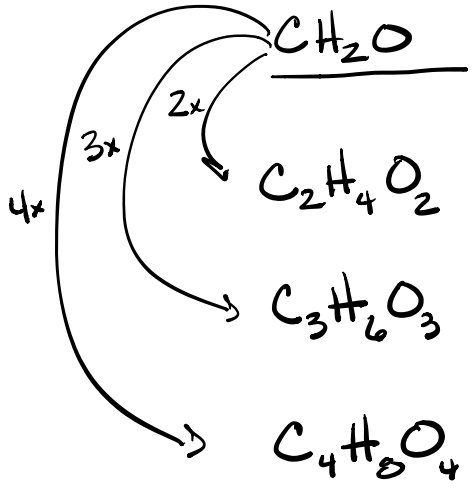
Ethanol

or



Dimethyl ether

Structural Isomers – two molecules that have different structures but the same molecular formula



Emperical Formula
= Smallest whole number ratios of a formula

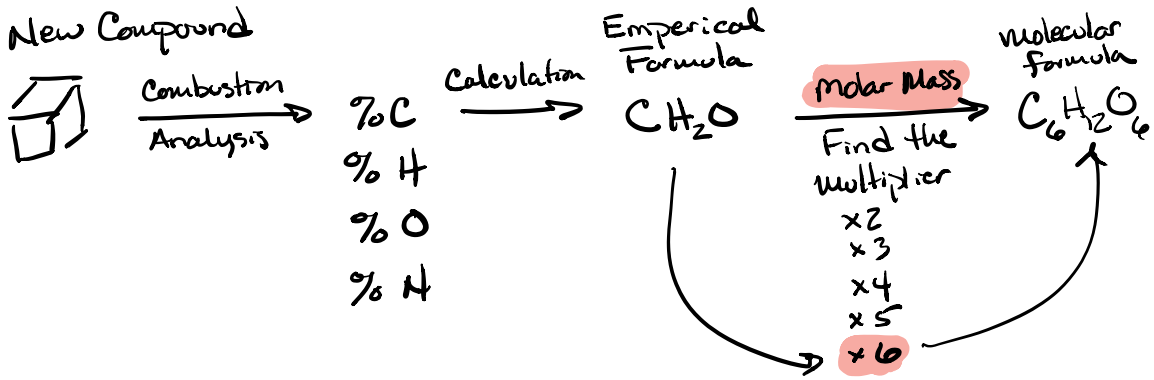
Example glucose $C_6H_{12}O_6$

Find the empirical formula for glucose

$$\frac{C_6}{6}\frac{H_{12}}{6}\frac{O_6}{6} = CH_2O$$

Simplist whole # Ratios

why do we have or want emperical formulas? Why are they useful?



Find the emperical formula for each formula below.

Molecular Formulas

a) $C_2H_4O_2$ = CH_2O Emperical formula

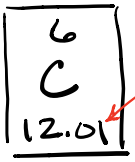
(÷2 ÷2 ÷2)

b) $NaC_2H_3O_2$ = $NaC_2H_3O_2$ Emperical formula

already smallest ratio

Molecular formula = Emperical

Molar Mass – mass in grams of 1 mole of a substance



Viewed as amu for 1 atom amu/atom

or

$\Rightarrow$ g for 1 mole of C atoms

g/mole

12.01 g C = 1 mole C atoms = 6.022×10^{23} C atoms

mass $\rightleftharpoons$ Count

Ex

How many grams will 3.21 moles of Carbon weigh?

Road Map

mole ⟶ grams

Equality Comes from PT

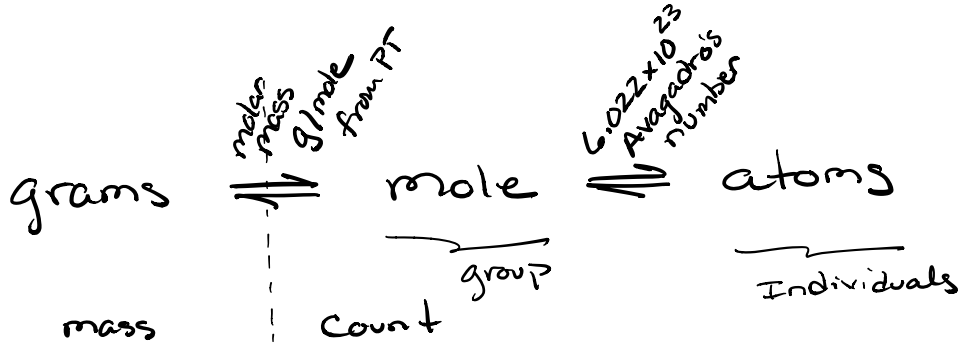
6
C
12.01

12.01 g Carbon atoms = 1 mole Carbon atoms

$$3.21 \text{ moles Carbon atoms} \times \frac{12.01 \text{ grams Carbon atoms}}{1 \text{ moles Carbon atoms}} = 38.5521 \text{ g C}$$

$$= 38.6 \text{ g C}$$

General Road Map

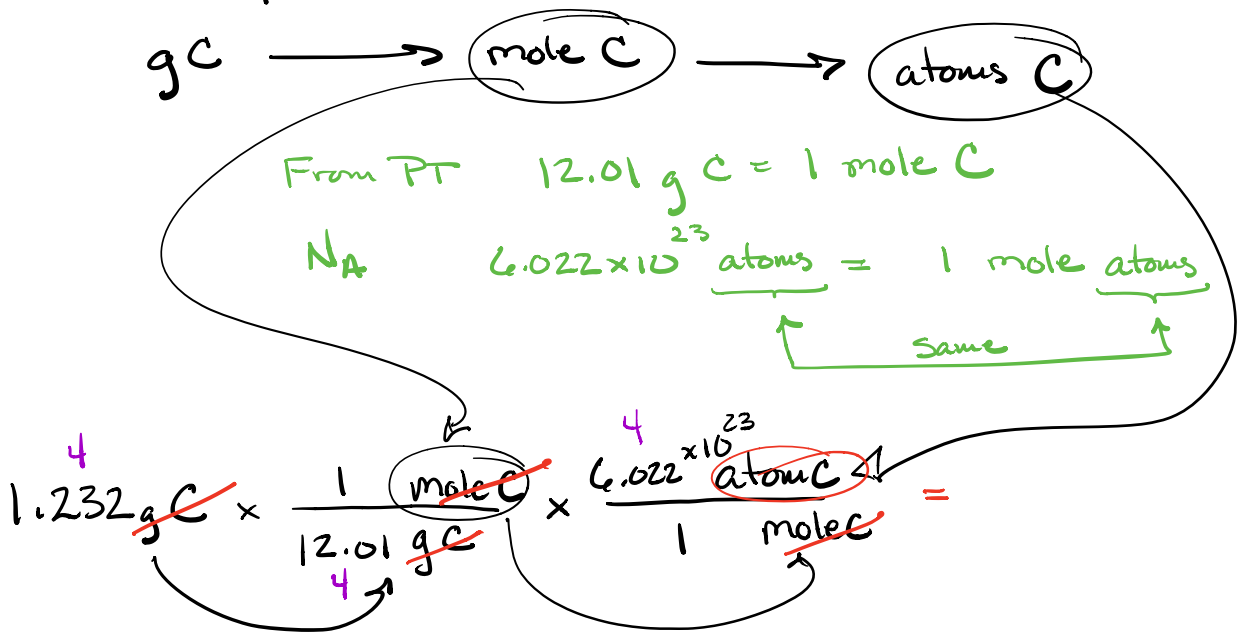


a) How many carbon atoms are in a diamond weighing 1.232g?

b) How many moles of Carbon is this

Part a

Road Map



1.232 ÷ 12.01 × 6.022 EE 23 = 6.177438801 × 10^{22}

EE
$\times 10^x$

= 6.177×10^{22} atoms of C

b) How many moles of Carbon atoms is in 1.232g of C?

Road Map

Need this part

g → mole → atoms

from PT

12.01 g Carbon = 1 mole Carbon

$$1.232\ \text{g C} \times \frac{1\ \text{mole C}}{12.01\ \text{g C}} =$$

$1.232 \div 12.01 = 0.102581182$

$= 0.1026\ \text{mole C}$

$\Rightarrow$ answer to atoms $\approx \times 10^{23}$

because atoms are so small

$\Rightarrow$ answer to moles $\approx$ slightly greater or smaller than 1

because moles are huge group

Equalities from Chemical Formulas

H_2O_1

whole # Ratios

atom equalities

2 atom Hydrogen = 1 molecule of H_2O

1 atom Oxygen = 1 molecule of H_2O

part — whole

2 atoms Hydrogen = 1 atom Oxygen

part — part

Ex $C_2H_4Br_2$ Write some equalities for the formula

Parts to whole

2 C atoms = 1 $C_2H_4Br_2$ molecule

4 H atoms = 1 $C_2H_4Br_2$ molecule

2 Br atoms = 1 $C_2H_4Br_2$ molecule

Part to part

2 C atoms = 2 Br atoms or 1 C atom = 1 Br atom

4 H atoms = 2 Br atoms or 2 H atoms = 1 Br atom

Ex

Desired Part

How many Br atoms are in 3.72×10^{16} molecules of $C_2H_4Br_2$?

Given Whole

equalities reside here

Road Map

molecules $C_2H_4Br_2$ → atoms Br

2 Br atoms = 1 $C_2H_4Br_2$ molecule

(3) 3.72×10^{16} molecules $C_2H_4Br_2$ × $\frac{2 \text{ atoms Br}}{1 \text{ molecule } C_2H_4Br_2}$ = atoms Br

Exact

Counted Ratios

$3.72 \times 10^{16} \times 2 = 7.44 \times 10^{16}$ = 7.44×10^{16} atoms Br

$C_2H_4Br_2$ → ×2 → Br 2 atoms

1 molecule

Individual

6.022×10^{23} boxes

$C_2H_4Br_2$ → ×2 → $2 \times 6.022 \times 10^{23}$ Br

1 mole of boxes

2 × 1 mole

How many moles

Mole Group

$C_2H_4Br_2$ has two meanings

1 molecule $C_2H_4Br_2$ = 2 atoms Br Individuals

or

1 mole (6.022×10^{23}) molecules $C_2H_4Br_2$ = 2 mole (6.022×10^{23}) atoms Br Groups

Same as

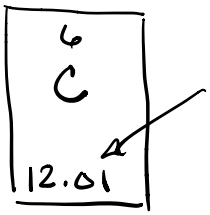
1 mole $C_2H_4Br_2$ = 2 mole Br

$A = B$

$cA = cB$

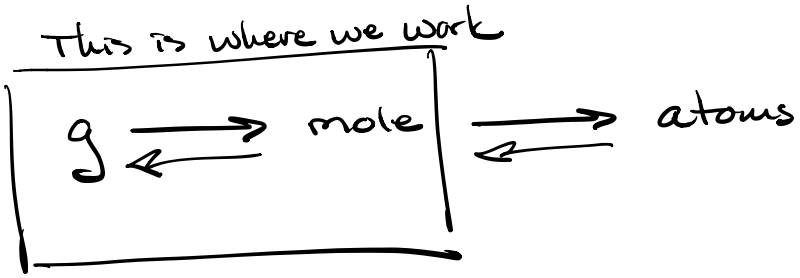
$A = B$

$6.022 \times 10^{23} A = 6.022 \times 10^{23} B$



g per mole

12.01 g = 1 mole C ~~atoms~~ dropped off



$$C_x H_y O_z X_c$$

Subscripts are most useful as molar subscripts that relate the part to whole & part to part

equalities

- x mole C = 1 mole $C_x H_y O_z X_c$
- x mole C = y mole H