- New homework assignment up
  ⇒ Canvas

- Answer key up for Chapter 1

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Chapter 2.4 Chemical formulas

Different representations

- Chemical formula (compounds)

NH_3 N_1H_3

1 nitrogen
3 hydrogens

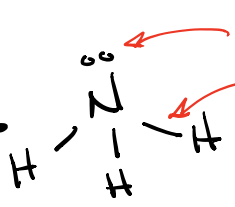
CH_4

$NaC_2H_5O_1$

Shows the ratios of elements in the compound

- Lewis Structure (Atom Connectivity)
  - Also Structural formula
  - Also bond line formula

Ammonia



- Atom Connectivity
- 3D Shape

Molecular View – 3 Dimensional & Can Show the e^- cloud

C N O H Halogens

Chemical formula w/ Structural Info

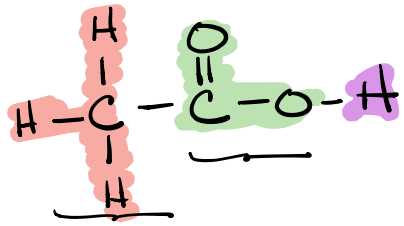
Structural Info CH_3COOH

molecular formula $C_2H_4O_2$

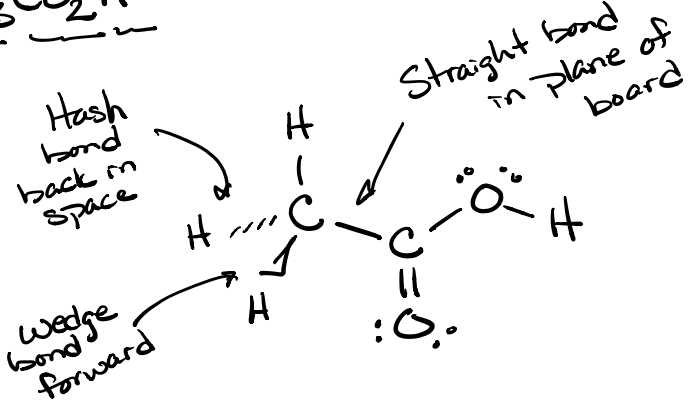
} Same

Molecular formula

Metal C H O N Halogen(X)

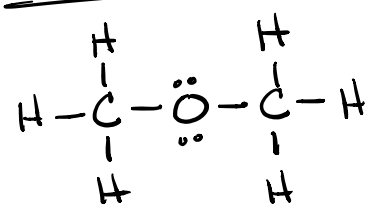
$CH_3COOH \equiv$ 

CH_3CO_2H



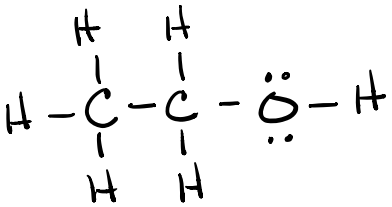
C_2H_6O molecular formula

Possible Structural Formulas



Dimethyl ether

C_2H_6O

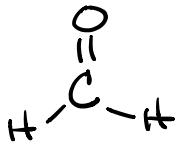


Ethanol or Ethyl alcohol

C_2H_6O

Structural Isomers - Two molecules that have the same molecular but different Structural Formulas.

CH_2O



Formaldehyde

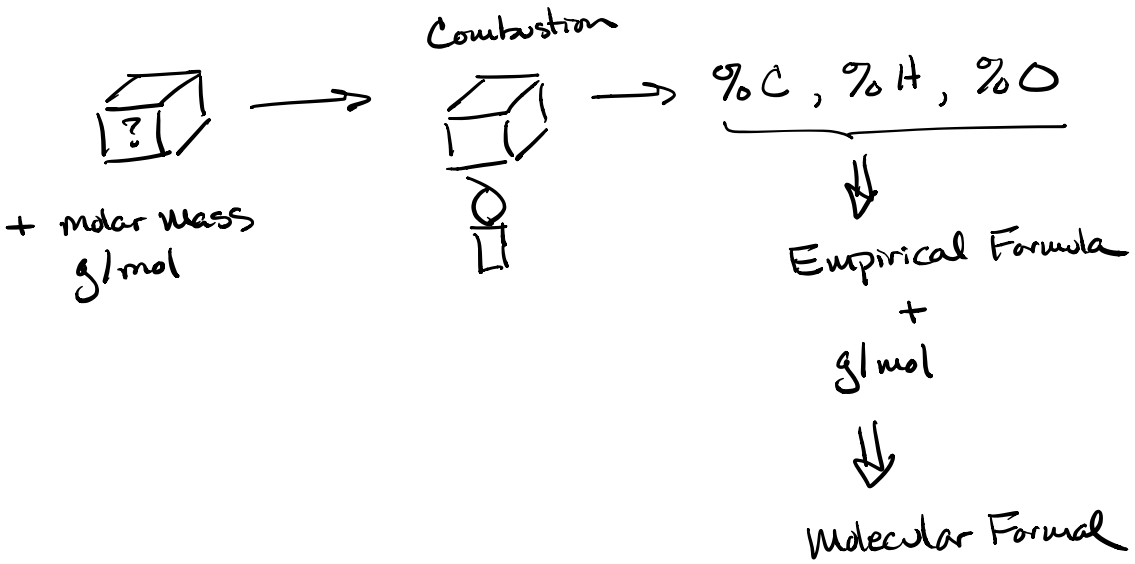
$C_2H_4O_2$

$C_3H_6O_3$

$C_4H_8O_4$

Empirical formula has the smallest whole # ratios

CH_2O Empirical formula



$n \times$ Emperical formula = Molecular

$3 \times CH_2O = C_3H_6O_3$

$$n = \frac{\text{whole molecular mass}}{\text{Emperical mass part}}$$

n: whole # value

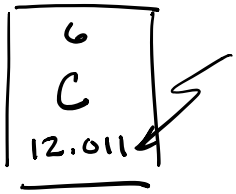
Molecular Glucose $C_6H_{12}O_6$

Empirical Formula CH_2O

Molecular Formula $NaC_2H_3O_2$

Empirical Formula $NaC_2H_3O_2$

Molar Mass



viewed as

amu/atom amu

or

⇒ g / mole of atoms g/mole

12.011 g C = 1 mole C atoms

mass ⇌ Count

Ex How many grams will 3.21 moles of Carbon weigh?

Road Map

moles C → g Carbon (molar mass 12.011 g/mole)

$$3.21 \text{ moles C} \times \frac{12.011 \text{ g C}}{1 \text{ mole C}} = 38.5531 \text{ g C}$$

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

How many Carbon atoms are in a diamond weighing 1.232 g? How many moles of Carbon is this?

Road Map

g/mole from PT

$N_A = 6.022 \times 10^{23}$

g → mole C → C atoms

$$1.232\ g\ C \times \frac{1\ mole\ C}{12.011\ g\ C} \times \frac{6.022 \times 10^{23}\ C\ atoms}{1\ mole\ C} =$$

$$= 6.176924486 \times 10^{22}\ C\ atoms$$

$$= \boxed{6.177 \times 10^{22}\ C\ atoms}$$

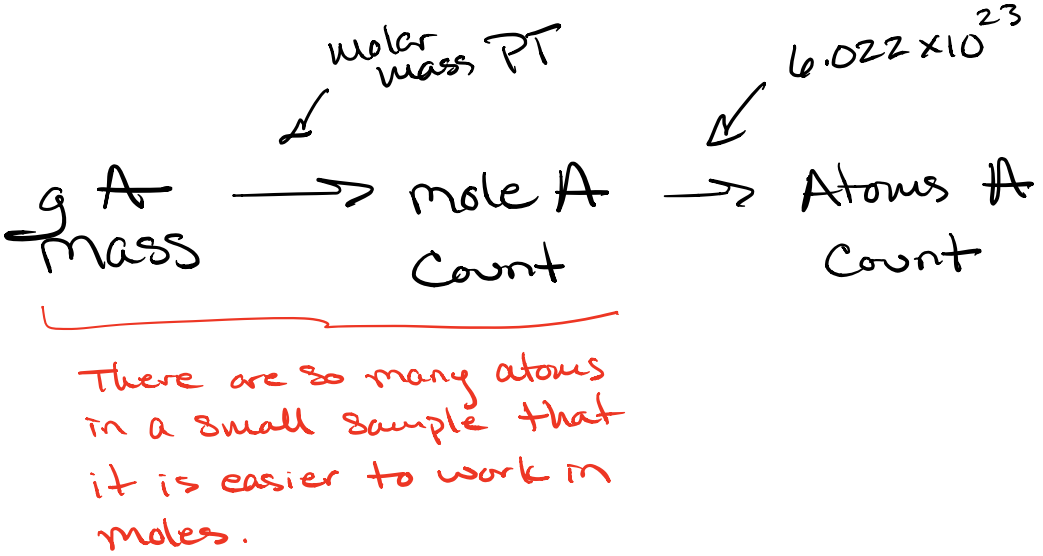
12.011 ⇒ g/mole ⇒ 12.011 g = 1 mole

B) How many moles does this represent

g → mole C

$$1.232\ g\ C \times \frac{1\ mole\ C}{12.011\ g\ C} = 0.1025726417\ mole$$

$$= \boxed{0.1026\ mole\ C}$$



Equalities from Chemical Formulas

H_2O

Whole # Ratios

1 H_2O 1

2 hydrogens to 1 H_2O

1 oxygen to 1 H_2O

2 Hydrogens to 1 Oxygen

Equalities

2 H atoms = 1 H_2O molecule

1 O atom = 1 H_2O molecule

part whole

2 H atom = 1 oxygen atom

part part

$C_2H_4Br_2$

Relationships are Equalities

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

2 C atoms = 4 H atoms

2 C atoms = 2 Br atoms

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

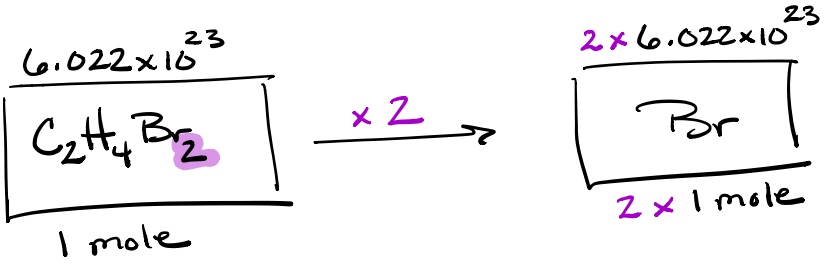
$C_2H_4Br_2$ molecule ⟶ Br atoms

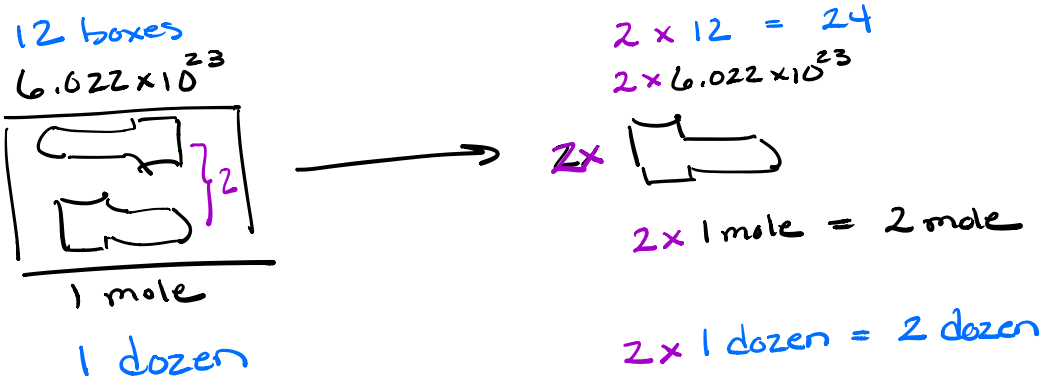
Counted ⇒ Exact

$$3.72 \times 10^{16} \text{ molecules } C_2H_4Br_2 \times \frac{2 \text{ atoms Br}}{1 \text{ molecule } C_2H_4Br_2} = 7.44 \times 10^{16} \text{ Br atoms}$$

3 sig figs

3 sig figs





$C_2H_4Br_2$

Ratio

1 molecule $C_2H_4Br_2$ = 2 atoms Br

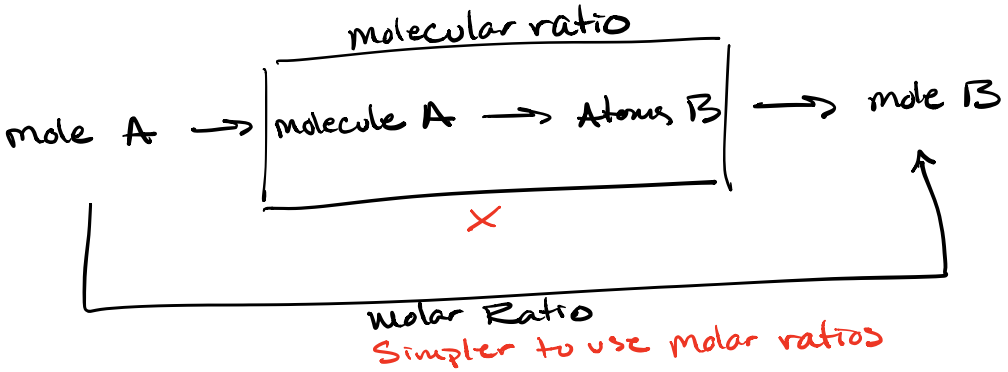
or

1 mole $C_2H_4Br_2$ = 2 moles Br

↳ of molecules

↳ atoms

molar ratio



Given 1.62 moles of $C_2H_4Br_2$, How many moles of Br are in the sample?

mole $C_2H_4Br_2$ → molecules $C_2H_4Br_2$ → atoms Br → moles Br

Equalities:
- 1 mole $C_2H_4Br_2$ = 6.022×10^{23} molecules $C_2H_4Br_2$
- 1 molecule $C_2H_4Br_2$ = 2 atoms Br
- 6.022×10^{23} atoms Br = 1 mole Br

$$1.62 \text{ mole } C_2H_4Br_2 \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mole } C_2H_4Br_2} \times \frac{2 \text{ atoms Br}}{1 \text{ molecule } C_2H_4Br_2} \times \frac{1 \text{ mole Br}}{6.022 \times 10^{23} \text{ atoms Br}}$$

$$= 3.24 \text{ mole Br}$$

mole $C_2H_4Br_2$ → mole Br

$$1.62 \text{ moles } C_2H_4Br_2 \times \frac{2 \text{ mole Br}}{1 \text{ mole } C_2H_4Br_2} = 3.24 \text{ moles Br}$$

molar Ratios

How much does a molecule of H_2O weigh

1 oxygen atom $\times \frac{16.00 \text{ amu}}{1 \text{ oxygen}}$ (4 sig figs, from PT) $= 16.00$ amu

2 hydrogen atoms $\times \frac{1.008 \text{ amu}}{1 \text{ hydrogen}}$ (4 sig figs) $= + 2.016$ amu

18.016 amu → 18.02 amu / H_2O molecule

8
O
16.00

amu for an individual atom

or

16.00 g for 1 mole of oxygen atoms

How much does a mole of H_2O weigh?

2 mole H $\times \frac{1.008 \text{ g H}}{1 \text{ mole H}}$ (4 sig figs) $= 2.016$ g

1 mole O $\times \frac{16.00 \text{ g O}}{1 \text{ mole O}}$ (4 sig figs) $= 16.00$ g

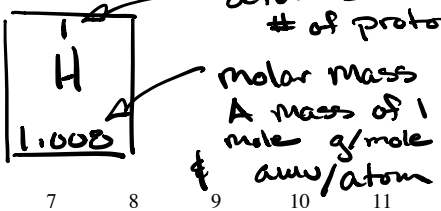
$+$

18.016 g / 1 mole H_2O → 18.02 g / 1 mole H_2O

$18.02 \text{ g } H_2O = 1 \text{ mole } H_2O$

Periodic → Regular Repeating Pattern

Periodic Table



1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H Hydrogen 1.008	2 2A																2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.30	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.84	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 97.91	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3		72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium 209	85 At Astatine 210	86 Rn Radon 222
87 Fr Francium 223	88 Ra Radium 226		104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 263	107 Bh Bohrium 262	108 Hs Hassium 265	109 Mt Meitnerium 266	110 Ds Darmstadtium 269	111 Uuu Ununnium 272	112 Uub Ununbium 277	113	114 Uuq Ununquadium 289	115	116 Uuh Ununhexium 289	117	118
Lanthanides			57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinides			89 Ac Actinium 227	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237	94 Pu Plutonium 244	95 Am Americium 243	96 Cm Curium 247	97 Bk Berkelium 247	98 Cf Californium 251	99 Es Einsteinium 252	100 Fm Fermium 257	101 Md Mendelevium 258	102 No Nobelium 259	103 Lr Lawrencium 262