What is the formula of strontium bromide?
A. SrBr
B. SrBr$_2$
C. SrBr$_3$
D. Sr$_2$Br
E. Sr$_3$Br

What is the formula of lithium nitride?
A. LiN
B. LiN$_2$
C. LiN$_3$
D. Li$_2$N
E. Li$_3$N

But some metals have multiple oxidation states

Plumbous chloride PbCl$_2$
Plumbic chloride PbCl$_4$

Mercury is Weird
Hg$_2$Cl$_2$
HgCl$_2$

But some metals have multiple oxidation states

Plumbous chloride PbCl$_2$
Plumbic chloride PbCl$_4$

Special polyatomic molecular ions

ammonium NH$_4^+$
carbonate CO$_3^{2-}$
nitrite NO$_2^-$
hypochlorite ClO$_2^-$
nitrate NO$_3^-$
chlorite ClO$_2^-$
sulfite SO$_3^{2-}$
chlorate ClO$_3^-$
sulfate SO$_4^{2-}$
perchlorate ClO$_4^-$
hydrogensulfate HSO$_4^-$
permanganate MnO$_4^-$
nitrogen monoxide NO
nitric oxide

peroxide O$_2^{2-}$
superoxide O$_{2^+}$
What is a mole?
Avogadro's number of something
What is Avogadro's number?
The number of carbon atoms in 12 grams of 12C.

6.022137 \times 10^{23}

Glucose \ C_6H_{12}O_6
How many moles in 10 grams?

What is molecular weight (mass) of glucose?
H 1 g/mol \ C 12 g/mol \ O 16 g/mol

6\times12 + 12\times1 + 6\times16 = 180 g/mol

10 g / 180 g per mole = 0.055 moles

For a compound which is 85.63% C and 14.37% H, what is the molecular formula?

• Assume 100 g of compound. This would contain 85.63 g C and 14.37 g H.
• 85.63 g / 12.01 g/mole C = 7.13 mole C.
• 14.37 g / 1.008 g/mole H = 14.26 mole H.

What is the molecular formula of this compound?

A. \text{CH}_2
B. \text{C}_2\text{H}_4
C. \text{C}_7\text{H}_{14}
D. \text{C}_{13}\text{H}_{24}
E. I have no idea

One-mole samples of copper, sulfur, mercury, and carbon

<table>
<thead>
<tr>
<th>Element</th>
<th>Number of Atoms</th>
<th>Mass of Sample (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>6.022 \times 10^{23}</td>
<td>26.98</td>
</tr>
<tr>
<td>Gold</td>
<td>6.022 \times 10^{23}</td>
<td>196.97</td>
</tr>
<tr>
<td>Iron</td>
<td>6.022 \times 10^{23}</td>
<td>55.85</td>
</tr>
<tr>
<td>Sulfur</td>
<td>6.022 \times 10^{23}</td>
<td>32.07</td>
</tr>
<tr>
<td>Boron</td>
<td>6.022 \times 10^{23}</td>
<td>10.81</td>
</tr>
<tr>
<td>Xenon</td>
<td>6.022 \times 10^{23}</td>
<td>131.30</td>
</tr>
</tbody>
</table>

Elemental Analysis

• Elemental analysis gives us the composition of a compound (the percentage by mass of the elements in the compound). We use the atomic weights to calculate the relative atom percents, which give us the empirical formula.

Water \ H_2O \ mol wt. = 2 \times 1 g + 1 \times 16 g = 18 g/mol

100 \ % \times 2 g / 18 g = 11.11 \% \ H

100 \ % \times 16 g / 18 g = 88.9 \% \ O

Another compound is 5.8\% H and 94.2\% O
Assume 100 g

5.8 g H/1 g per mol = 5.8 mol H

94.2 g O/16 g per mol = 5.8 mol O

H_2O_2 \ \text{hydrogen peroxide}

A chemist has an unknown organic compound containing the elements C, H and Cl only. A 0.250 g sample of the compound is subjected to combustion in an oxygen rich atmosphere. The CO_2 and H_2O from the combustion reaction are trapped and weighed. The CO_2 has a mass of 0.587 g and the of H_2O has a mass of 0.100 g.

What is the empirical formula of the unknown compound?

0.587 g CO_2 \times 12 g C / 44 g CO_2 = 0.160 g C \times 1 \text{mol/12g C} = 0.0133 \text{mol C}

0.100 g H_2O \times 2 g H / 18 g H_2O = 0.011 g H \times 1 \text{mol/1g H} = 0.011 \text{mol H}

0.250 g - 0.160 g C - 0.011 g H = 0.079 g Cl \times 1 \text{mol/35.45g Cl} = 0.0022 \text{mol Cl}
\[
C_6H_5Cl
\]

0.0133 mol C / 0.0022 = 6.04
0.011 mol H / 0.0022 = 5.00
0.0022 mol Cl / 0.0022 = 1

\[
C_6H_5Cl
\]

0.587 g CO₂ x 12 g C / 44 g CO₂ = .160 g C x 1 mol/12 g C = .0133 mole C
0.100 g H₂O x 2 g H / 18 g H₂O = .011 g H x 1 mol/1 g H = .011 mole H
0.250 g - .160 g C - .011 g H = .079 g Cl x 1 mol/35.45 g Cl = .0022 mole Cl

How many Double Whoppers?

A double Whopper with cheese requires 2 beef patties, 3 bun slices, and a cheese slice. How many can you make from 6 beef patties, 12 bun slices, and 6 cheese slices?

A. 3
B. 4
C. 6
D. 12

Limiting Reagent: 2A + 3B + C → D

- You mix 6 moles A and 12 moles B with 6 moles of C and allow them to react. Which is the limiting reagent?

6/2 = 3 you could get 3 moles of D based on A
12/3 = 4 you could get 4 moles of D based on B
6/1 = 6 you could get 6 moles of D based on C

A is thus the limiting reagent

If you allow 10.0 grams of cyclohexene to react with 25.0 grams of Br₂ how many grams of dibromobenzene should you get?

Which reactant is the limiting reagent?

A. Cyclohexene
B. Bromine

Hint: Calculate the moles of each reagent. Which is smaller?

\[
\begin{align*}
H \quad 1.0 \text{ g/mol } \\
C \quad 12.0 \text{ g/mol } \\
Br \quad 79.9 \text{ g/mol }
\end{align*}
\]

\[
\begin{align*}
\text{C}_6\text{H}_{10} & \rightarrow \text{C}_6\text{H}_{10}\text{Br}_2 \\
\text{Br}_2 \quad \text{Br}_2
\end{align*}
\]

But things are seldom perfect. What if you carried out the reaction and isolated 27.3 grams. What is the percentage yield?

\[
100% \times \frac{27.3 \text{ g}}{29.5 \text{ g}} = 92.5% 
\]

\[
0.122 \text{ mole} \times 241.8 \text{ g/mole} = 29.5 \text{ grams product}
\]