# The Mole

Q: how long would it take to spend a mole of $1 coins if they were being spent at a rate of 1 billion per second?

## Background: atomic masses

- Look at the "atomic masses" on the periodic table. What do these represent?
- E.g. the atomic mass of C is 12 (atomic # is 6)
- We know there are 6 protons and 6 neutrons
- Protons and neutrons have roughly the same mass. So, C weighs 12 u (atomic mass units).
- What is the actual mass of a C atom?
- Answer: approx. $2 \times 10^{-23}$ grams (protons and neutrons each weigh about $1.7 \times 10^{-24}$ grams)

Two problems

1. Atomic masses do not convert easily to grams
2. They can't be weighed (they are too small)

## The Mole

With these problems, why use atomic mass at all?

1. Masses give information about # of $p^+$, $n^0$, $e^-$
2. It is useful to know relative mass
   E.g. Q - What ratio is needed to make $H_2O$?
   A - 2:1 by atoms, but 2:16 by mass

- It is useful to associate atomic mass with a mass in grams. It has been found that 1g H, 12g C, or 23g Na have $6.02 \times 10^{23}$ atoms
- $6.02 \times 10^{23}$ is a "mole" or "Avogadro's number"
- "mol" is used in equations, "mole" is used in writing; one gram = 1 g, one mole = 1 mol.
- Read 4.3 (167-9). Stop after text beside fig 2.
- Do Q1-6. Challenge: 1st slide (use reasonable units)

## Comparing sugar ($C_{12}H_{22}O_{11}$) & $H_2O$

| Same | 1 gram each | 1 mol each |
|---|---|---|
| volume? | | |
| mass? | | |
| # of moles? | | |
| # of molecules? | | |
| # of atoms? | | |

## Molar mass

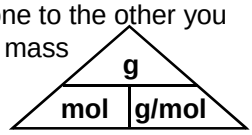
- The mass of one mole is called "molar mass"
- E.g. 1 mol Li = 6.94 g Li
- This is expressed as 6.94 g/mol
- What are the following molar masses?
  S  $SO_2$
  $Cu_3(BO_3)_2$

Calculate molar masses (to 2 decimal places)

$CaCl_2$
$(NH_4)_2CO_3$
$O_2$
$Pb_3(PO_4)_2$
$C_6H_{12}O_6$

## Converting between grams and moles

- If we are given the # of grams of a compound we can determine the # of moles, & vise-versa
- In order to convert from one to the other you must first calculate molar mass
  g = mol x g/mol
  mol = g ÷ g/mol

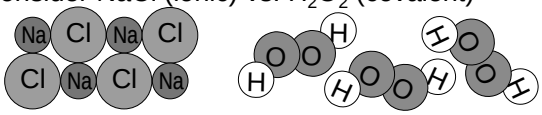



- This can be represented in an "equation triangle"

| Formula | g/mol | g | mol (n) | Equation |
|---|---|---|---|---|
| HCl | | | 0.25 | g= g/mol x mol |
| $H_2SO_4$ | | 53.15 | | |
| NaCl | | | 3.55 | |
| Cu | | 1.27 | | |

## Simplest and molecular formulae

Consider NaCl (ionic) vs. $H_2O_2$ (covalent)




- Chemical formulas are either "simplest" (a.k.a. "empirical") or "molecular". Ionic compounds are always expressed as simplest formulas.
- Covalent compounds can either be molecular formulas (I.e. $H_2O_2$) or simplest (e.g. HO)

Q - Write simplest formulas for propene ($C_3H_6$), $C_2H_2$, glucose ($C_6H_{12}O_6$), octane ($C_8H_{14}$)

Q - Identify these as simplest formula, molecular formula, or both $H_2O$, $C_4H_{10}$, CH, NaCl