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Counting Atoms Study Guide

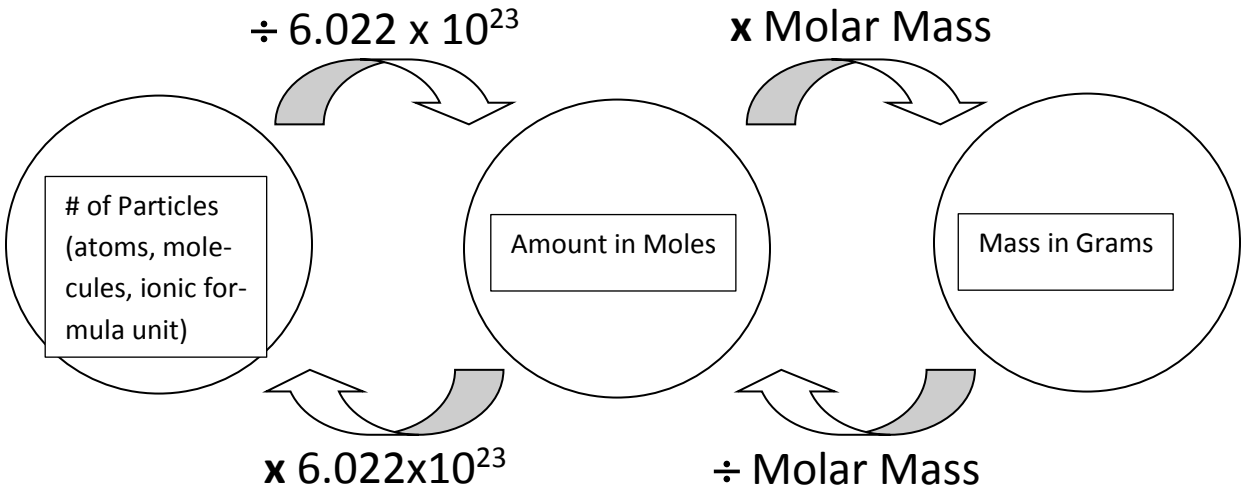
Part I - Definitions:

A mole is defined as the number of atoms in **12** grams of Carbon-12. The number of atoms or molecules in a mole is known as **Avogadro's** number, and is equal to **6.022×10^{23}**. A mole is the SI unit for **amount** of a pure substance.

A mole has a different **mass** depending upon the substance it is measuring: just as a dozen bowling balls weigh more than a dozen ping-pong balls. The mass of a mole of a particular substance is the **molar** mass of that substance. Molar mass has **units** of grams/mole. The molar mass of an element is a mass in **grams** numerically equal to the **atomic** mass for that element in the Periodic Table. The molar mass of a compound is equal, in grams, to the **sum** of the atomic masses of the atoms which make up the compound.

Word Bank: 6.022×10^{23}, 12, molar, grams, units, amount, Avogadro's, mass, atomic, element, sum

Part II - Mole, Grams, and Particle Calculations



Number of moles in 10 grams of HF:

10 g ÷ 20.01 g/mol = 0.50 mol

Number of atoms in 5 moles of Cu:

5 mol Cu x $\frac{6.022 \times 10^{23}}{}$ = 3.011×10^{24} atoms

Number of atoms in 56 grams of Si:

(56 g Si ÷ 28.086 g/mol) x $\frac{6.022 \times 10^{23}}{}$
= 1.2×10^{24} atoms

Number of grams in 2 moles of H_2O:

2 mol x 18 g/mol = 36 g

Number of moles in 1.2044×10^{22} atoms of Al:

1.2044×10^{22} atoms ÷ $\frac{6.022 \times 10^{23}}{}$ = 0.02 mol

Number of grams in 3.011×10^{24} atoms of U:

(3.011×10^{24} atoms ÷ 6.022×10^{23}) x 238 g/mol
= 1190 grams

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More Practice:

How many moles are in 90 grams of water (H_2O)? **90 ~~g H_2O~~ x mol H_2O / 18 ~~g H_2O~~ = 5 mol H_2O**

How many grams of mass do 3 moles of NH_3 have? **3 ~~mol NH3~~ x 17 g NH3 / ~~Mol NH3~~ = 51 g NH_3**

How many atoms are in 0.1 moles of an element? **0.1 mol x 6.022×10^{23} / mol = 6.022×10^{22}**

What is the mass in grams of 10^{26} atoms of lithium (Li)? **1×10^{26}** x **~~mol~~ / 6.022×10^{23} x 6.941 g Li / ~~mol~~ = 1153 g**

Formulas and Moles:

A chemist wants to prepare the compound BH_3. She has 21.6 grams of boron (B). How many grams of Hydrogen does she need? **There are 3 times as many atoms of H as there are atoms of B.**
There are 3 times as many moles of H as there are moles of B.
So how do we solve this? **Start with grams of B, conv to MOLES of B, find MOLES of H, conv to GRAMS.**

21.6 g B ÷ 10.8 g/mol = 2 mol B _____2_____ mol B x _3____ = ____6_____ mol H

_____6_____ mol H x ___1.0079___ g/mol = 6.04 g H

A chemist wants to prepare the compound LiBr. She has 0.694 grams of Li. How many grams of Bromine does she need? **The formula LiBr means we have the same amount in moles of Li as of Br.**

0.694 ~~g Li~~ x ~~mol Li~~ / 6.941 ~~g Li~~ x 1 ~~mol Br~~ / 1 ~~mol Li~~ x 79.904 g Br / ~~mol Br~~ = 0.694 * 79.904 / 6.941 = 7.99 g Br

"the mole ratio"
this is what the formula LiBr really means. It means 1:1 ratio of Li and Br atoms!

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HONORS: A cube of titanium (Ti) has a volume of one cubic centimeter. The density of titanium is 4.506 grams/cm^3.

How many atoms of Titanium are in this cube?

$$\frac{1\ \cancel{cm^3}}{} \times \frac{4.506\ \cancel{g}}{\cancel{cm^3}} \times \frac{\cancel{mol}}{47.867\ g} \times \frac{6.022 \times 10^{23}}{\cancel{mol}} = 5.67 \times 10^{22}$$

Assuming these atoms are arranged in an NxNxN cubic lattice, what is N?

$\sqrt[3]{5.67 \times 10^{22}} = 38417374$ **or** 3.84×10^7

Assuming that the spacing of the lattice is equal to one atomic diameter, what is the diameter of a Ti atom?

$1\ cm / 3.84 \times 10^7$ **atoms** $= 2.6 \times 10^{-8}$ **cm or** 2.6×10^{-10} **m**