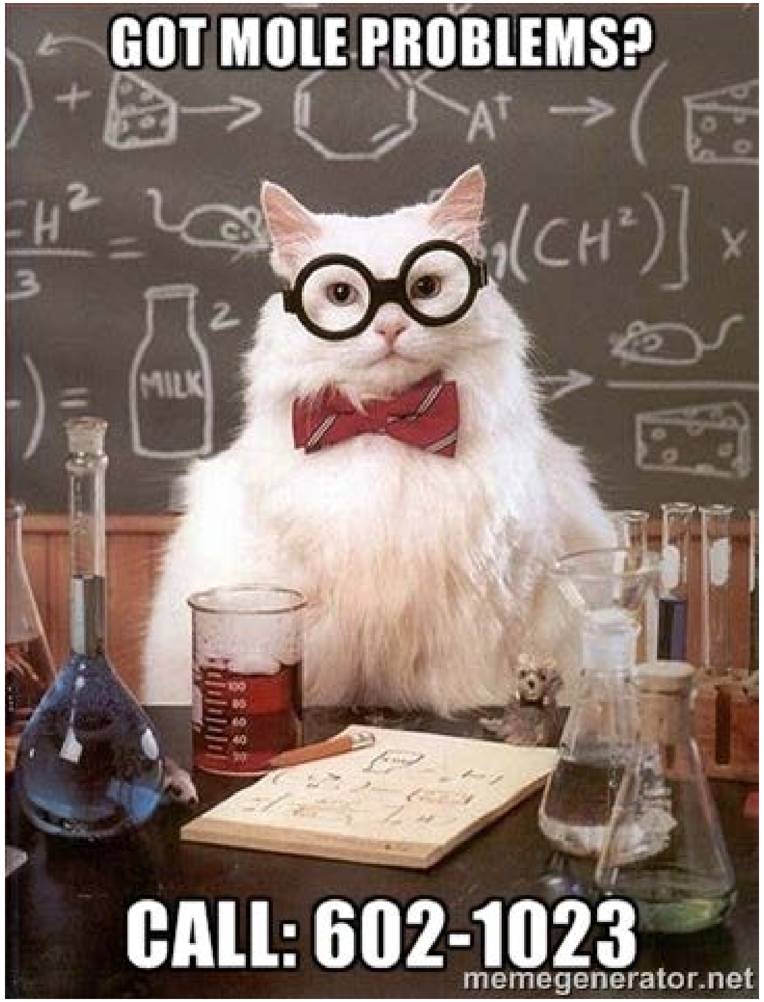
Moles & Particles



Outcome:

Solve problems requiring inter-conversions between moles, mass, volume, and number of particles.

Moles & Particles

We know that 1 mole = **<u>6.02 x 10²³</u>** **<u>THINGS</u>** (particles) In chemistry, the "**<u>THINGS</u>**" will either be **<u>MOLECULES</u>** or **<u>ATOMS</u>**.　　H_2O　　Na

If we have the amount of particles (atoms/molecules) of a substance, we can use Avogadro's number to find how many moles we have.

Think of a mole as a "**<u>PACKAGE</u>** of **<u>SOMETHING</u>**", like a **<u>DOZEN</u>**.

We can use units to do our calculations, just as before…

$$\text{mol} \times \frac{6.02 \times 10^{23}\ \text{particles}}{1\ \text{mol}} = \text{particles}$$

$$\text{particles} \times \frac{1\ \text{mol}}{6.02 \times 10^{23}\ \text{particles}} = \text{mol}$$

Moles & Particles

Examples:

If we had 2 moles of pennies, how many would this be? How much money is this?

$$2\ \text{mol} \times \frac{6.02\times10^{23}\ \text{pennies}}{1\ \text{mol}} = 1.204\times10^{24}\ \text{pennies}$$

\$ 1,204000000000000000000000

How many moles are there in 1.7 x 10^{18} atoms of copper?

$$1.7\times10^{18}\ \text{atoms} \times \frac{1\ \text{mol}}{6.02\times10^{23}\ \text{atoms}} = 2.82\times10^{-6}\ \text{mol}$$

How many molecules are there in 7.0 mol O_2?

$$7.0\ \text{mol} \times \frac{6.02\times10^{23}\ \text{molecules}}{1\ \text{mol}} = 4.214\times10^{24}\ \text{molecules}$$

Moles & Particles

Try this one…

If you had one water molecule, how many moles of water would you have?

$$1 \text{ molecule} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecule}} = 1.66 \times 10^{-24} \text{ mol}$$

Moles & Particles (atoms in a molecule)

If your **PARTICLES** are **ATOMS**, they **CANNOT** be broken down further

→ an atom is the smallest part of an element.

Example:

How many atoms of hydrogen are there in 2 moles of hydrogen atoms?

$$2\,\text{mol} \times \frac{6.02\times10^{23}\ \text{atoms}}{1\ \text{mol}} = 1.2\times10^{24}\ \text{atoms H}$$

Moles & Particles (atoms in a molecule)

If our **PARTICLES** are **MOLECULES**, they **CAN** be broken down further into atoms

Examples:

How many atoms of hydrogen are there in 2 moles of hydrogen gas (H_2)?

molecule

$$2\text{ mol} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}} = 1.2\times10^{24}\text{ molecules } H_2 \times \frac{2\text{ atoms H}}{1\text{ molecule } H_2} = 2.4\times10^{24}\text{ atoms H}$$

How many atoms of each element are in 2 moles of water?

molecule

$$2\text{ mol } H_2O \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}} = 1.2\times10^{24}\text{ molecules } H_2O \times \frac{2\text{ atoms H}}{1\text{ molecule}} = 2.4\times10^{24}\text{ atoms H}$$

$$\times \frac{1\text{ atom O}}{1\text{ molecule}} = 1.2\times10^{24}\text{ atoms O}$$

Moles & Particles (atoms in a molecule)

Try this one…

How many atoms of each element are there in 0.5 moles of N_2O_5?

molecule

$6 N_2O_5$

$0.5\text{ mol} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}} = 3.01\times10^{23}\text{ molecules } N_2O_5$

$3.01\times10^{23}\text{ molecules} \times \frac{2\text{ atoms N}}{1\text{ molecules}} = 6.02\times10^{23}\text{ atoms N}$

$\times \frac{5\text{ atoms O}}{1\text{ molecule}} = 1.51\times10^{24}\text{ atoms O}$

$0.5\text{ mol } N_2O_5 \times \frac{2\cdot N}{1\text{ car}} = 1\text{ mol N}$

$\times \frac{N_A\text{ atoms N}}{1\text{ mol}} = 6.02\times10^{23}\text{ atoms N}$

Moles & Particles (atoms in a molecule)

We can also find the number of moles of atoms in a molecule using the same logic…

Example:

How many **moles** of each element are found in 0.5 moles of N_2O_5?

$$0.5 \text{ mol } N_2O_5 \times \frac{2 \text{ atoms N}}{1 \; N_2O_5} = 1 \text{ mol N} \times \frac{N_A \text{ atoms}}{1 \text{ mol}} = 6.02 \times 10^{23} \text{ atoms N}$$

$$\times \frac{5 \text{ O's}}{1 \; N_2O_5} = 2.5 \text{ mol O}$$

Notice that we can now use Avogadro's number to find the number of atoms just like before….

Moles & Particles (atoms in a molecule)

Try this one…

How many moles of each element are found in 0.2 moles of magnesium hydroxide?

$Mg(OH)_2$

$$0.2 \text{ mol } Mg(OH)_2 \times \frac{1 - Mg}{1 - Mg(OH)_2} = 0.2 \text{ mol } Mg$$

$$\times \frac{2 - O\text{'s}}{1 - Mg(OH)_2} = 0.4 \text{ mol } O$$

$$\times \frac{2 - H}{1 - Mg(OH)_2} = 0.4 \text{ mol } H$$

Moles & Particles (atoms in a molecule)

We can also include our molar mass calculations from before…

Examples:

1. Determine the number of atoms of hydrogen that would be found in 36g of water.

$$36g \times \frac{1 \text{ mol}}{18.02 \text{ g}} = 2 \text{mol} \times \frac{N_A \text{ molecules}}{1 \text{ mol}} = 1.2 \times 10^{24} \text{ molecules} \times \frac{2 \text{ atoms H}}{1 \text{ molecule}} = 2.411 \times 10^{24} \text{ atoms H}$$

2. What would be the mass of 20 molecules of water?

$$20 \text{ molecules} \times \frac{1 \text{mol}}{N_A \text{ molecules}} = 3.32 \times 10^{-23} \text{ mol} \times \frac{18.02 \text{ g}}{1 \text{ mol}} = \longrightarrow 5.99 \times 10^{-22} \text{ g}$$

Moles & Particles (atoms in a molecule)

Examples (cont.):

3. What would be the mass of 1 atom of sodium? → g

$$1 \text{ atom} \times \frac{1 \text{ mol}}{N_A \text{ molecules}} = 1.66 \times 10^{-24} \text{ mol} \times \frac{23 \text{ g}}{1 \text{ mol}} = 3.82 \times 10^{-23} \text{ g}$$

Try this one…

How many chlorine atoms are in 1.0g of carbon tetrachloride? → CCl_4 $12 + (35.5 \times 4)$

$$1.0 \text{ g} \times \frac{1 \text{ mol}}{154 \text{ g}} \times \frac{N_A \text{ molecules}}{1 \text{ mol}} \times \frac{4 \text{ atoms Cl}}{1 \text{ molecules}} = 1.56 \times 10^{22} \text{ atoms Cl}$$