Chemical (Mole) Conversions

Terms that Represent a certain amount

- A Pair of shoes= 2 shoes
- Dozen Eggs =12 eggs
- Gross of pencils= 144 pencils
- A Ream of paper = 500 sheets
- What term do we use in chemistry to Represent a certain number of atoms/partices?????

What is the mole?

We’re not talking about this kind of mole!

What is a mole?

- Mole- the amount of substance
- 1mole of any substance = 6.02×10^{23} particles of that substance
- 6.02×10^{23} – is called avagadro's number
- Particles is a generic term= this term will change depending on the type of stubstance. The following terms will be use:
  - Element= **atoms**
  - Ionic compound (metal & non-metal)- Formula Unit
  - Covalent compound (non metl & non-metal)- **Molecule**
  - Ion- **ions**

- This is a conversion factor: 1mole of any substance = 6.02×10^{23} particles
- It can be written as $\frac{6.02 \times 10^{23}}{1\text{mole}}$ or $\frac{1\text{mole}}{6.02 \times 10^{23}}$

How you write it will depend on what they give you in the problem.

Converting Days to seconds

- 1 day=24hr 1hour=60min 1min=60 seconds
- How many seconds is in 4.46 days?

This problems would be set up like this:

$$\frac{4.46 \text{ days}}{} \times \frac{24\text{hr}}{1\text{day}} \times \frac{60\text{min}}{1\text{hr}} \times \frac{60\text{sec}}{1\text{min}} = 385{,}344 \text{ sec}$$

Some units will cancel out and then you will be left with seconds.
Notice the units that cancel are on top & bottom.

Particle to mole Conversions

How to set up the problem

This will be a number and unit given in the Question

Remember: the word Particle will be replaced with terms such as atoms, molecules, formula units, or ions

$$\text{Given} \times \frac{1 Mole}{6.02x1023 \text{ particles}}$$

Ex: How many moles is 7.78×10^{24} formula units of $MgCl_2$?

$$\frac{7.78 \times 10^{24} \text{ formula units}}{} \times \frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ formula units}} = 12.9 \text{ moles}$$

Hint: To get units to cancel: one has to be on top of the line and the other has to be on bottom

Mole to Particle conversions

Remember: the word Particle will be replaced with terms such as atoms, molecules, formula units, or ions

How to set up the problem:

This will be a number and unit given in the Question

$$\text{Given (mole)} \left| \frac{6.02x1023particles}{1mole} \right.$$

Hint: Notice this time the conversion factor is flipped, the 1mole is now on the bottom. The unit that goes on the bottom is the same unit that is in the given part of the question.

How many molecules of CO_2 are in 4.56 moles of CO_2?

$$\frac{4.56\text{mole}}{1\text{mole}} \left| \frac{6.02\text{x}10^{23}}{} \right. = 2.75 \text{ x } 10^{24} \text{ molecules}$$

Conversions that include Grams of substance

Molar Mass

Molar mass (also called “molecular weight” or “molecular mass”): The weight of one mole of a chemical compound. The unit is “g/mol”.

- For elements, the mass of one mole of atoms is called the “**atomic mass**” and is found on the periodic table (decimal number).
- For chemical compounds, it’s the sum of the masses of all of the atoms in the molecule.

How to calculate the molar mass of a compound:

- For elements, the molar mass is the same thing as the atomic mass.
- For chemical compounds, it's the sum of the masses of all of the atoms in the molecule.
- Example: CO_2

C:	12.01 grams x 1 atom =	12.01 grams
O:	16.00 grams x 2 atom =	32.00 grams
Total:	1mole of CO_2 =	44.01 grams

Converting Grams to Mole

How to set up the problem

This will be a number, unit, and formula given in the Question

What goes in the blank is the molar mass of the compound (you calculate it)

Converting Grams to Moles

How many moles is in **24.31 g MgO**?

$$\frac{24.31\text{g MgO}}{\dfrac{1\text{mol}}{40.31\text{ g}}} = \textbf{0.603 mol of MgO}$$

Molar Mass goes here.
You calculate it.

Molar Mass of MgO

Mg:	24.31 grams x 1 atom =	24.31 grams
O:	16.00 grams x 1 atom =	16.00 grams
	Total:	= 40.31 grams

Converting Moles to Grams

How to set up the problem

What goes in the blank is the molar mass of the compound (you calculate it)

This will be a number, unit, and formula given in the Question

$$\text{Given (moles) include the formula} \times \frac{\_\_\_\_\,grams}{1\,mole}$$

Converting Moles to Grams

What is the mass (how many grams) is **47moles $Mg(OH)_2$** ?

$$\frac{47 \text{ mole } Mg(OH)_2}{1 \text{ mole}} \quad \frac{58.33 \text{ g}}{} = \textbf{2,741.51 g of } Mg(OH)_2$$

Molar Mass goes here.
You calculate it.

Molar Mass of $Mg(OH)_2$

Mg:	24.31 grams x 1 atom =	24.31 grams
O:	16.00 grams x 2 atom =	32.00 grams
H:	1.01 grams x 2 atoms=	2.02 grams
	Total:	= 58.33 grams

Conversions involving Gasses

The Mole-Volume Relationship

- Many of the chemicals we deal with are in the physical state as: gases.
  - They are difficult to *weigh (or mass)*.
- But, we may still need to know how many moles of gas we have.
- Two things effect the volume of a gas:
  a) Temperature and b) Pressure
- We need to compare all gases at the same temperature and pressure. So we compare them at a unit known as Standard Temperature and Pressure (STP)

Standard Temperature and Pressure
STP

- STP = 0ºC and 1 atm pressure
- At STP, 1 mole of *any gas* occupies a volume of 22.4 L = Called the molar volume
- This is a conversion factor: 1 mole of *any gas at STP* = 22.4 L
  - *1mole = 22.4L*

Converting Mole to volume (liters)

How to set up the problem

This will be a number and unit given in the Question

Remember: Every gas at STP occupies the same amount of space(volume) = 22.4L

$$\text{Given (mole)} \left| \frac{22.4\ L}{1 mole} \right.$$

Converting Moles to Volume (liters)

What is the volume of 4.59 mole of CO_2 gas at STP?

$$\frac{4.59 \text{ mole}}{1 \text{ mole}} \times \frac{22.4\text{L}}{} = 103 \text{ L of } CO_2$$

Converting volume (liters) to Moles

How to set up the problem

This will be a number and unit given in the Question

$$\text{Given (liters)} \left| \frac{1 mole}{22.4 L} \right.$$

Remember: Every gas at STP occupies the same amount of space(volume) = 22.4L

Converting Volume (liters) toMoles

How many moles is 5.67 L of O_2 at STP?

Number and unit given in the question

$$\frac{5.67\ \text{L}}{} \times \frac{1\ \text{mole}}{22.4\ \text{L}} = 0.253\ \text{mol}\ O_2$$

Density of a gas

- D = m / V (density = mass/volume)
  - for a gas the units will be: grams per liter (g / L)

- We can determine the density of any gas at STP if we know its formula.

Density = Molar Mass / 22.4L

Conversions that involve more than one conversion Factors

There is 6 different types of problem:

Particle→Gram	Gram→particle
Volume → Gram	Gram→ Volume
Volume→particle	Particle→Volume

particle(aka: atom, molecule, formula units)

We have 3 conversion factors:

- 1mole = 6.02×10^{23} particles
- 1mole = __(molar mass)_____ grams
- 1mole = 22.4L

Hints:

If the question does not have the term “moles” then you will use 2 conversion factors.

Setting up the problems (you will have 2 “T’s” in the set up):

1. Underline the number and unit they give you. This will help you pick the 1st conversion factor. Then write this at the beginning of the T and then copy that unit at the bottom.
2. Circle what they ask you to find. That will help you find the 2nd conversion factor. This unit will be at the end on the top of the T.
3. Moles will cancel so there will be a mole on top and bottom

Converting Particles to grams

Remember: the word Particle will be replaced with terms such as atoms, molecules, formula units, or ions

Molar Mass goes here. You calculate it.

$$\frac{Given\ (particles)}{} \left| \frac{1mole}{6.02x1023} \right| \frac{\_\_\_\_grams}{1mole} =$$

Hints:

- Particles will cancel and so will moles.
- You will multiply across the top and bottom then divide those answers.

Converting Particles to grams

How many grams does $4.5x10^{34}$ molecules of H_2O weigh?

Molar Mass of H_20.

$$\frac{4.5x1023\ \text{molecules}}{} \left| \frac{1mole}{6.02x1023} \right| \frac{18.02\ grams}{1mole} = \frac{8.11x1024}{6.02x1023} = 13.5g$$

Remember: the word Particle will be replaced with terms such as atoms, molecules, formula units, or ions

Converting Grams to Particles

Remember: the word Particle will be replaced with terms such as atoms, molecules, formula units, or ions

$$\frac{Given\ (grams)}{1} \left| \frac{1 mole}{\_\_\_ grams} \right| \frac{6.02x1023\ particles}{1 mole} =$$

Molar Mass goes here.
You calculate it.

Hints:

- Grams and moles will cancel
- You will multiply across the top and bottom then divide those answers.

Converting Particles to grams

How many formula units of $Mg(OH)_2$ does 58.8grams contain?

$$\frac{58.8\ g\ of\ Mg(OH)_2}{} \left| \frac{1mole}{58.33g} \right| \frac{6.02\ x1023\ formula\ units}{1mole} = \frac{3.54x1025}{58.33} = 6.07x1023 \text{formula units}$$

Molar Mass of $Mg(OH)_2$.

More with 2 conversion Factors:

Volume to Grams:

$$\frac{Given\ (Liters)}{} \left| \frac{1mole}{22.4\ L} \right| \frac{\_\_\_grams}{1mole}$$

Grams to Particles:

$$\frac{Given\ (grams)}{} \left| \frac{1mole}{\_\_\_grams} \right| \frac{22.4\ L}{1mole}$$

Volume to atom/molecule/Formula unit:

$$\frac{Given\ (Liters)}{} \left| \frac{1mole}{22.4\ L} \right| \frac{6.02x1023\ atom,molecule,form.u.}{1mole}$$

Atom/molecule/Formula unit to Grams:

$$\frac{Given\ (atom,molecule,form.u.)}{} \left| \frac{1mole}{6.02x1023} \right| \frac{\_\_\_grams}{1mole}$$