KEY

(topic 11→12)

Chemistry 20

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Topic 11 Moles

In chemistry 20 we use unit conversions eventually leading to stoichiometry. This is an important concept, as stoichiometry is THE MAJOR UNIT in chem. 20.

Unit conversions work by cancelling out units you don't want, and turning them into units you do want.

Examples:

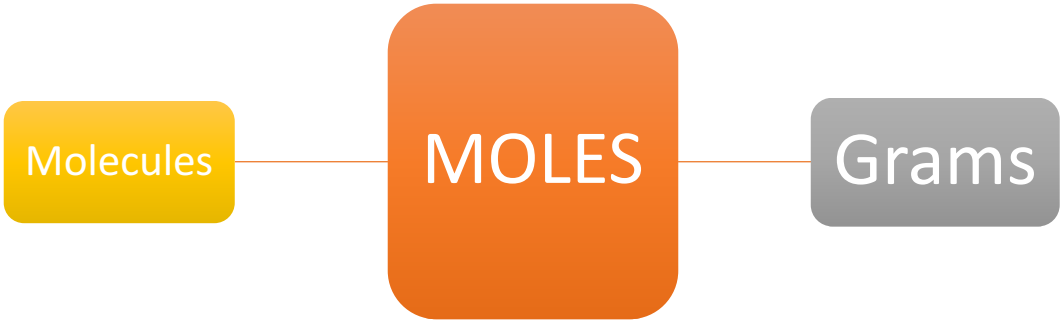
1. Using unit conversions, determine how many seconds there are in 2.83hours.

ANS: 10188 seconds

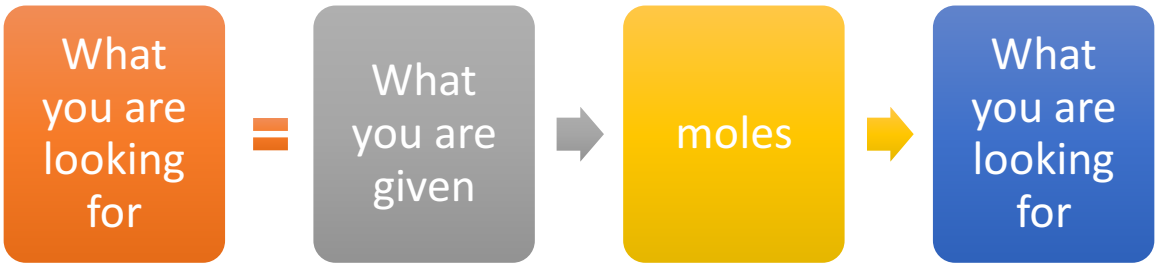
2. Using unit conversions, determine how many Litres there are in 0.283mL of water.

ANS: 0.000283L

In the same way, we can use unit conversions to determine moles or mass given the molar mass of a compound.



Examples:



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3. Calculate the number of kilograms in 1293.84 grams

ANS: 1.29384kg

4. Calculate the number of moles in 1.38kg of Cu(s)

ANS: 21.7mol

5. Calculate the number of molecules in 0.00273moles NaCl

ANS: 1.64×10^{21}molecules

6. Calculate the number of grams in 2.25×10^{21}molecules of $AgNO_3$

ANS: 0.635g

7. Calculate the number of molecules in 250g of water

ANS: 8.35×10^{24}molecules

Examples:

3. Calculate the number of kilograms in 1293.84 grams

$$\#\,kg = 1293.84\,g \times \frac{1\,kg}{1000\,g} = 1.29384\,kg$$

4. Calculate the number of moles in 1.38kg of Cu(s)

$$\#\,moles\ Cu = 1.38\,kg \times \frac{1000\,g}{1\,kg} \times \frac{1\,mol}{63.55\,g} = 21.7\,mol$$

5. Calculate the number of molecules in 0.00273moles NaCl

$$\#\,molec = 0.00273\,mol \times \frac{6.02 \times 10^{23}\,molec}{1\,mol} = 1.64 \times 10^{21}\ molecules$$

6. Calculate the number of grams in 2.25×10^{21}molecules of $AgNO_3$

$$\#\,g\ AgNO_3 = 2.25 \times 10^{21}\,molec \times \frac{1\,mol}{6.02 \times 10^{23}\,molec} \times \frac{169.88\,g}{1\,mol} = 0.635g$$

7. Calculate the number of molecules in 250g of water

$$\#\ molec\ H_2O = 250g \times \frac{1\,mol}{18.02\,g} \times \frac{6.02 \times 10^{23}\,molec}{1\,mol} = 8.35 \times 10^{24}\,molec$$

Practice:

1. Calculate the number of moles for the following:

   a. 25g of carbon dioxide

$$\#\text{mol } CO_2 = 25\text{ g} \times \frac{1\text{ mol}}{44.01\text{ g}} = 0.568\text{ mol}$$

   b. 1.28×10^{26} molecules of water

$$\#\text{mol} = 1.28 \times 10^{26}\text{ molec} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ molec}} = 212.62\text{ mol}$$

2. Calculate the number of grams for the following:

   a. 0.0027392 moles of silver nitrate $AgNO_3$

$$\#\text{g} = 0.0027392\text{ mol} \times \frac{169.88\text{ g}}{1\text{ mol}} = 0.46534\text{ g}$$

   b. 12.472×10^{19} molecules of barium sulfide BaS

$$\#\text{g} = 12.472 \times 10^{19}\text{ molecules} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ molecules}} \times \frac{169.40\text{g}}{1\text{ mol}} = 0.0351\text{ g}$$

3. Calculate the number of molecules for the following

   a. 4.38 grams of tetraphosphorus decaoxide P_4O_{10}

$$\#\text{molec} = 4.38\text{ g} \times \frac{1\text{ mol}}{283.88\text{g}} \times \frac{6.02 \times 10^{23}\text{ molec}}{1\text{ mol}} = 9.29 \times 10^{21}\text{ molecules}$$

   b. 0.00274kg of boric acid H_3BO_3

$$\#\text{molec} = 2.74\text{ g} \times \frac{1\text{mol}}{61.84\text{ g}} \times \frac{6.02 \times 10^{23}\text{ molec}}{1\text{ mol}} = 2.67 \times 10^{22}\text{ molec.}$$

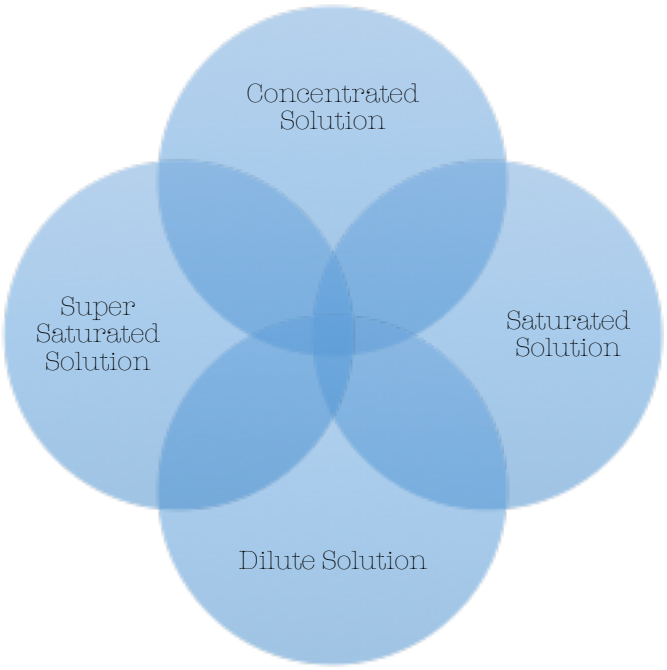
4. Complete the following chart using unit conversions. Include proper sig figs in your chart.

Compound	Moles	Molecules	Grams
Na_2SO_4	7.613×10^{-6}	4.583×10^{18}	0.001081
CO_2	0.000382671	2.300×10^{20}	0.01682
$Mg_3(PO_4)_2$	0.047122	2.8368×10^{22}	12.387
NH_4NO_3	57863.787	3.4834×10^{28}	4632574.8
$Ca(OH)_2$	3.82×10^{-4}	2.2996×10^{28}	0.283
Sucrose	0.18776	1.13×10^{23}	64.277

Topic 12 Molar Concentration

Knowing the concentration of a solution provides a way to find how much of a particular substance exists in a given volume of solution. This is important in chemistry, as it will allow for determination of pH and strength of acids and bases (eventually). Concentration can be defined as the amount of a specific substance in a known volume of solution.

Research using the internet or a textbook to complete the Venn Diagram below: **INQUIRY**



Molar Concentration = MOLARITY!

Molar concentration is the number of moles of the substance contained in **1L** of solution. The units for molarity is mol/L.

Units are ever important in chemistry, but molarity is so awesome it has 4 different ways of showing units!

- The unit symbol for mol/L is M
- M is stated as Molar
- Molar concentration is denoted as [...]
- mol/L = M = [ ] = molarity

Example 1
If a 1.0L solution contains 2.5mol of NaCl, what is the molar concentration? Express this value in 4 different ways.

ANS: 2.5mo/L = 2.5M = [2.5] = 2.5 molarity

Example 2
What mass of NaOH is contained in 3.50L of 0.200M NaOH?

ANS: 28g

Molar Concentration = MOLARITY!

Molar concentration is the number of moles of the substance contained in **1L** of solution. The units for molarity is mol/L. Although I do not teach formulas in chemistry 20, the formula for concentration is detailed below:

$$C = \frac{n}{V}$$

where C = concentration in mol/L
n = moles
V = volume in Litres

Units are ever important in chemistry, but molarity is so awesome it has 4 different ways of showing units!

- The unit symbol for mol/L is M
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- mol/L = M = [ ] = molarity

Example 1
If a 1.0L solution contains 2.5mol of NaCl, what is the molar concentration? Express this value in 4 different ways.

$\frac{mol}{L} = \frac{2.5\ mol}{1.0\ L} = \frac{2.5\ mol}{L} = [2.5] = 2.5\ M = 2.5$ molarity

Example 2
What mass of NaOH is contained in 3.50L of 0.200M NaOH?

$\#g = \frac{0.20\ mol}{L} \times 3.50\ L \times \frac{40\ g}{mol} = \boxed{28\ g}$

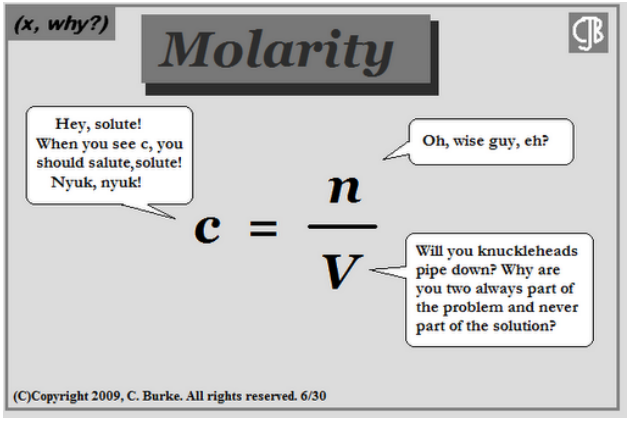
Example 3
What is the molarity of pure sulphuric acid, H_2SO_4, having a density of 1.839 g/mL?

ANS: 18.75M H_2SO_4

Example 4
What is the molarity of the $CaCl_2$ in a solution made by dissolving and diluting 15.00g of $CaCl_2$ $6H_2O$ to 500.0mL?

Remember when $CaCl_2$ $6H_2O$ dissolves in water it turns into $CaCl_2$ with equal number of moles therefore $[CaCl_2] = [CaCl_2\ 6H_2O]$

ANS: 0.1369M



* Example 3 *

What is the molarity of pure sulphuric acid, H_2SO_4, having a density of 1.839 g/mL?

$$\frac{\#\,mol}{L} = \frac{1.839\ g}{mL} \times \frac{1000\ mL}{1\ L} \times \frac{1\ mol}{98.09\ g} = 18.748\ \frac{mol}{L}$$

$$\frac{\#\,mol}{L} = \boxed{18.75\ M\ H_2SO_4}$$

Example 4

What is the molarity of the $CaCl_2$ in a solution made by dissolving and diluting 15.00g of $CaCl_2\ 6H_2O$ to 500.0mL?

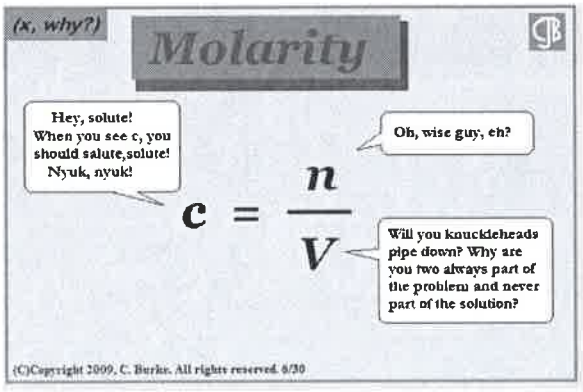
Remember when $CaCl_2\ 6H_2O$ dissolves in water it turns into $CaCl_2$ with equal number of moles therefore $[CaCl_2] = [CaCl_2\ 6H_2O]$

$$\frac{\#\,mol}{L} = 15.0\ g \times \frac{1\ mol}{219.10\ g} \times \frac{1}{0.50\ L} = 0.13692377791\ M$$

$CaCl_2 \cdot 6H_2O$

* calcium chloride hexa hydrate *

$= 0.1369\ M$



Practice Problems

1. What mass, in grams, of calcium nitrate are there in 867mL of a 2.00M calcium nitrate solution?

$$\#g\ Ca(NO_3)_2 = \frac{2.0\ mol}{L} \times 0.867\ L \times \frac{164.1\ g}{1\ mol} = 284.5494\ g$$

285 g

2. What is the molarity of a solution made by dissolving 20.0g silver nitrate in 225mL of water?

$$\frac{\#\ mol}{L}\ AgNO_3 = 20.0\ g \times \frac{1\ mol}{169.88\ g} \times \frac{1}{0.225\ L} = 0.523245\ M$$

0.523 M

3. What volume, in litres, of a 2.00M KCl solution contains 2.5g of KCl?

$$\#L_{KCl} = 2.5\ g \times \frac{1\ mol}{74.55\ g} \times \frac{1\ L}{2.0\ mol} = 0.016767\ L$$

0.017 L

4. The density of a 60.00% ethanol, C2H5OH solution is 0.8937 g/mL. What is the molarity of the solution?

C_2H_5OH

$$\frac{\#\ mol}{L} = \frac{0.8937\ g}{mL} \times \frac{1000\ mL}{L} \times \frac{1\ mol}{46.08\ g} = 19.3945\ mol/L$$

19.40 M

5. The concentration of a Pb(NO3)2 solution is 0.907M. What is the density of the solution in grams per mL?

$$\frac{\#\ g}{mL}\ Pb(NO_3)_2 = \frac{0.907\ mol}{L} \times \frac{1\ L}{1000\ mL} \times \frac{331.22\ g}{1\ mol} = 0.300416549\ g$$

0.300 g

6. Find the molar concentration of each of the ions in a solution that contains 0.165moles of aluminum chloride in 820mL? (show the dissociation equation first, and use ratios for the concentration of all ions)

$$AlCl_3 \longrightarrow Al^{3+}(aq) + 3Cl^-(aq)$$

[0.2012M] [0.2012M] [0.6037M]

$$\frac{mol}{L}\ AlCl_3 = \frac{0.165\ mol}{0.820\ L} = 0.2012\ M = [AlCl_3] = [Al^{3+}]$$

$\times 3 = 0.6037\ M = [Cl^-]$