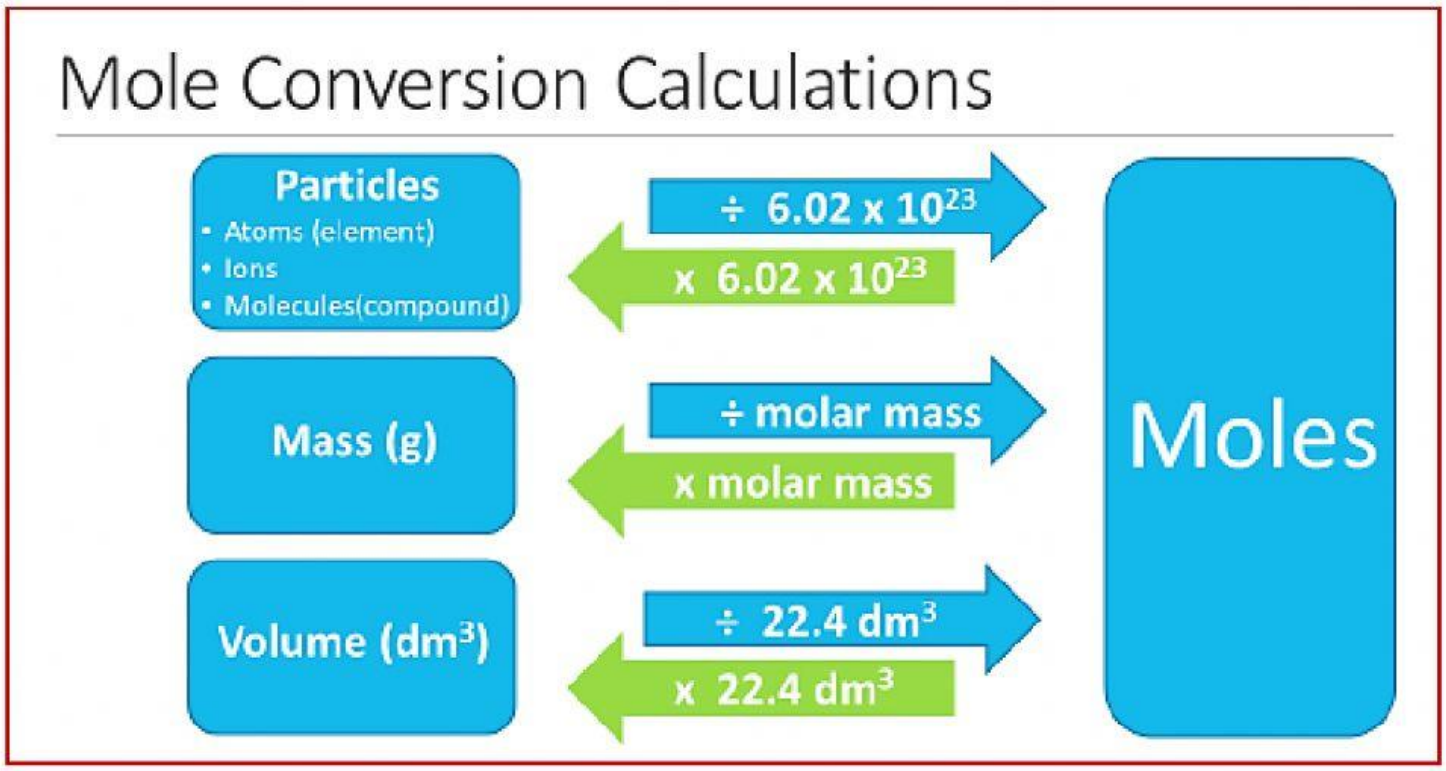
Mole – Part 5

We have now learnt 3 “triangles” for mole calculations:

1. Mass to mole conversion
2. No. of particles to mole conversion
3. Volume (gas) to mole conversion



In this worksheet we will learn the final “triangle” for mole calculations – calculating molar concentration of SOLUTIONS.

Solutions:

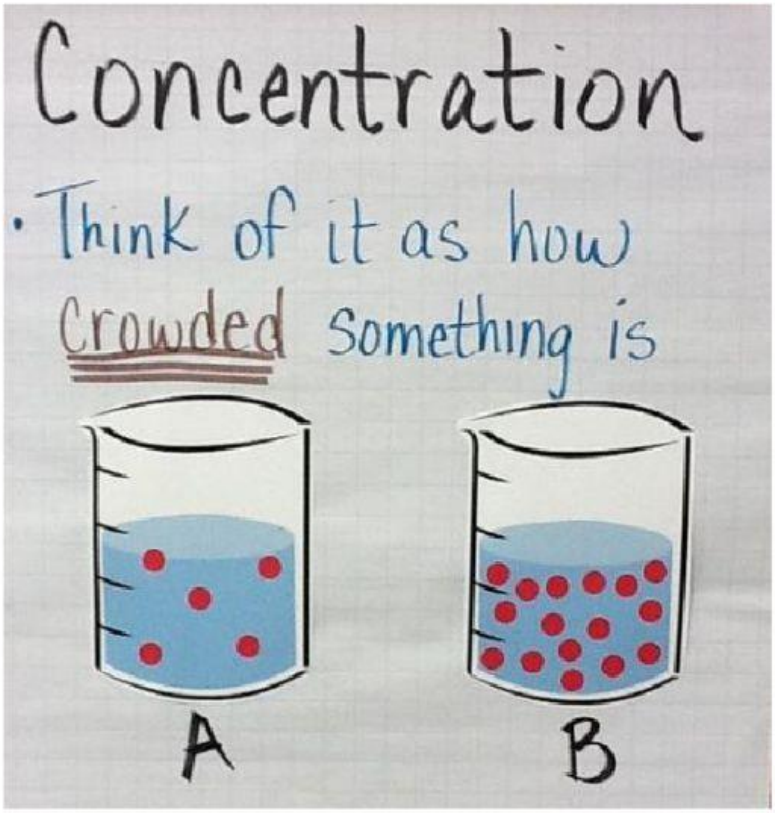
A solution is made up of a SOLUTE dissolved in a SOLVENT.

Concentration: the amount of solute present per volume of solution

SOLUTE: the substance that has dissolved into the solution

SOLVENT: the liquid that contains the solute

STANDARD SOLUTION: this is an accurately made up solution where the concentration is known precisely.



(http://www.bondwithjames.com)

A = low concentration

B = high concentration

Calculating Concentration:

Molar concentration = number of moles of solute per dm^3 (litre) of solvent.

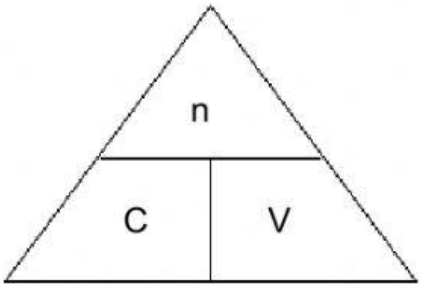
For example:

- 1 mol NaCl per 1 dm^3 $(1\ litre)$ solution = concentration of 1 $mol.dm^{-3}$
- 2 mol NaCl per 1 dm^3 $(1\ litre)$ solution = concentration of 2 $mol.dm^{-3}$
- 2 mol NaCl per 250 cm^3 $(\frac{1}{4}\ litre)$ solution = concentration of 8 $mol.dm^{-3}$
- 1,5 mol NaCl per 250 cm^3 $(\frac{1}{4}\ litre)$ solution = concentration of 6 $mol.dm^{-3}$

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

Where:

C = concentration ($mol.dm^{-3}$)
n = no of moles
V = volume of solvent (dm^3)



Examples:

1. A solution of volume 200 dm^3 contains 0,4 mol Na_2CO_3. Calculate the concentration of the solution.

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

$$= —$$

$$= \mathbf{0{,}002\ mol.dm^{-3}\ of\ Na_2CO_3}$$

2. Calculate the amount (number of moles) of NaOH in 250 cm^3 solution with a concentration of 2 $mol.dm^{-3}$.

Note: the volume has been given in cm^3 so first we need to convert this to dm^3

$V = 250\ cm^3 = \frac{250\ cm^3}{1000\ cm^3} =$ dm^3

$C = 2\ mol.dm^{-3}$

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

$$n = C \times V$$

$= \quad x$

$n =$ **mol NaOH**

3. Calculate the concentration of sodium nitrate ($NaNO_3$) if 4,25 g of $NaNO_3$ is dissolved in water to make up a 250 cm^3 solution.

Note: you have been given mass and you need to calculate concentration. You will need to use TWO triangles for this. First, mass to moles, then moles to concentration.

V = 250 cm^3 = $\frac{250\ cm^3}{1000\ cm^3}$ = **dm^3**

{ $M(NaNO_3) = 23 + 14 + 3(16)$ = **$g.mol^{-1}$**}

$n = \frac{m}{M}$ = — = **mol of $NaNO_3$**

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

= —

C = mol.dm^{-3} of $NaNO_3$

4. 6,675 g Aluminium chloride ($AlCl_3$) dissolves in water and the final solution has a volume of 500 cm^3. Calculate the concentration of the $AlCl_3$ solution.

M ($AlCl_3$) = + 3( ) = **$g.mol^{-1}$**

$n = \frac{m}{M}$ = — = **mol of $AlCl_3$**

v = 500 cm^3 = **dm^3**

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

$$= \text{—}$$

C = **mol.dm^{-3} of $AlCl_3$**

****Do the following exercise in the back of your Chemistry book. (It comes from pg 135 of your printed notes.)**

Question 8

8.1 What is meant by the concentration of a solution?

8.2 The concentration of a sodium chloride solution is 0,5 mol.dm^{-3}. Calculate the number of moles of the solute in:

8.2.1 3 dm^3 of the solution

8.2.2 20 ml of the solution

8.3 Calculate the concentration (in mol.dm^{-3}) of each of the following aqueous solutions:

8.3.1 3,65 g HCl in 1000 cm^3 solution

8.3.2 1,09 g KBr in 100 cm^3 solution

8.3.3 1,58 g $KMnO_4$ diluted to give 500 cm^3 of a solution

8.3.4 9,8 g H_2SO_4 diluted to give a 250 ml solution

8.4 Calculate the mass (in grams) of solute needed to prepare the following solutions:

8.4.1 200 cm^3 of a 0,1 $mol.dm^{-3}$ NaCl solution

8.4.2 100 ml of a 0,5 $mol.dm^{-3}$ KOH solution

8.5 A solution has a concentration of 0,7$mol.dm^{-3}$. This solution is diluted by taking 20cm^3 of this solution and adding water to it to create a solution with a volume of 90cm^3. Calculate the concentration of the diluted solution.

8.6 A solution has a concentration of 0,5$mol.dm^{-3}$. This solution is diluted by taking 60cm^3 of this solution and adding water to it to create a solution with a concentration of 0,3$mol.dm^{-3}$. Calculate the volume of water that is added to the solution.

8.7 A solution with a volume of 200cm^3 is created by using a 0,2$mol.dm^{-3}$ solution with a volume of 50cm^3 by adding water to the solution.

8.8 Calculate the volume of water that needs to be added to a solution with a concentration of 0,3 $mol.dm^{-3}$ and a volume of 100cm^3 in order to create a solution with a concentration of 0,1$mol.dm^{-3}$.

More exercises: **(pg 152 of printed notes)**

1. What is a mole?

2. Calculate the number of mol of the substance that is expressed by each of the given masses:
   a. 12 g Mg atoms
   b. 24 g Ammonia (NH_3)
   c. 6,4 g sulphur dioxide (SO_2)
   d. 1.5 g water

3. Calculate the mass (in gram) of each of the following substances which make up the following mol quantities:
   a. 0.6 mol carbon dioxide
   b. 10 mol HCl
   c. 0.25 mol $CaCO_3$
   d. 1 mol NaOH

4. What is the relationship between Avogadro's constant and a mol?

5. Precisely 1 mol of dicarbondecafluoride (C_2F_{10}) contains:
    a. How many C_2F_{10} atoms
    b. How many C atoms
    c. How many F atoms
    d. How many atoms in total

6.
    a. Calculate the number of moles of Na atoms in 0.23 g of Na
    b. How many atoms are there in 0.23 g of Na?

7.
    a. Calculate the number of moles of H_2 molecules in 4 g of H_2 gas.
    b. How many atoms are there in 4 g of H_2 gas?

8. Calculate the mass of 0,6 mol of sulphur dioxide (SO_2)

9. 1 mole of disulphurdecafluoride (C_2F_{10}) contains:
    a. How many C_2F_{10} molecules?
    b. How many C-atoms?
    c. How many F-atoms?
    d. How many atoms in total?

10. Calculate the mass of $1{,}806 \times 10^{24}$ Cu atoms.

11. How many hydrogen atoms are there in 5,1 g of NH_3?

12. How many atoms are there in 6 g of hydrogen gas?