N5: Mole calculations

Gram formula mass (GFM)

The GFM of a substance is the sum of the relative atomic masses (RAM) of all elements present. It is the mass in grams of one mole of a substance.

Examples:

NaCl CO_2 $Mg(NO_3)_2$

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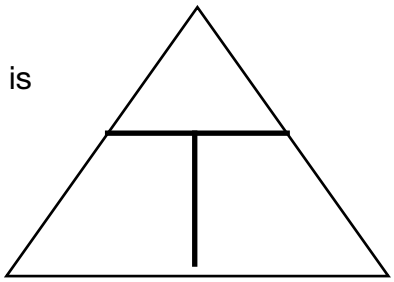
Calculate the gram formula mass of these substances

A) K_2O B) $CaCO_3$ C) $(NH_4)_3PO_4$

Moles = mass/gfm



One mole of a substance contains a specific number of particles. This is more useful to use than mass when comparing quantities of different substances reacting.

Moles = mass / gfm mass = moles x gfm

gfm = mass/moles

Examples: Calculate the number of moles present in 10g of Li_2O

Calculate the mass of 0.5 moles of $MgCl_2$

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A)Calculate the number of moles present in 20g of NaCl

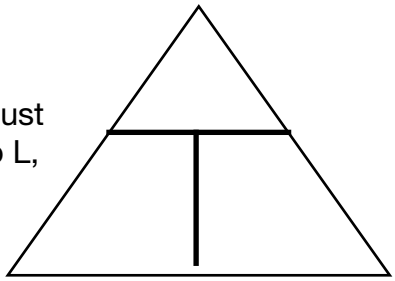
B) Calculate the number of moles present in 0.5g of NH_3

C) Calculate the mass of 10 moles of HF

D) Calculate the mass of 0.01 moles of $CaCO_3$

Moles = concentration x volume

Concentration is measured in moles per litre (mol l^{-1}). Volume must be in litres to carry out these calculations. To convert from ml to L, divide by 1000.



Moles = concentration x volume

concentration = moles/volume

volume = moles/concentration

Examples: Calculate the number of moles of solute present in 50 ml of a 1 mol l^{-1} solution.

Calculate the concentration of a 100 ml solution containing 0.5 moles of solute.

Calculate the volume of solution required to make a solution of concentration 0.5 mol l^{-1} from 0.025 moles of solute.

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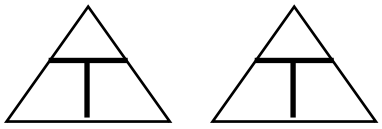
A) Calculate the number of moles of solute present in 100 ml of a 0.25 mol l^{-1} solution.

B) Calculate the concentration of a 25 ml solution containing 0.05 moles of solute.

C) Calculate the volume of solution required to make a solution of concentration 0.5 mol l^{-1} from 1 mole of solute.

Using mass and volume



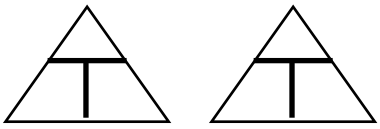
Examples: Calculate the mass of sodium fluoride (NaF) required to make 500 ml of a 0.5 mol l^{-1} solution.

Step 1: Calculate the moles of solute needed

Step 2: Calculate the GFM of NaF

Step 3: Calculate the mass required

Calculate the volume of solution required to make a 0.2 mol l^{-1} solution using 10g of magnesium nitrate ($Mg(NO_3)_2$).



Step 1: Calculate the GFM of magnesium nitrate

Step 2: Calculate the number of moles of solute needed

Step 3: Calculate the volume required.

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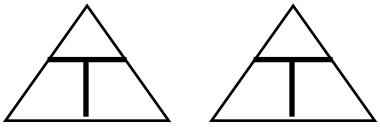
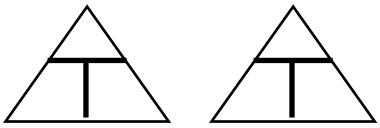
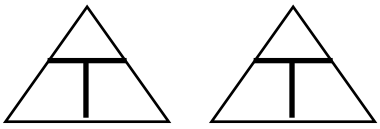
A) Calculate the mass of sodium chloride (NaCl) required to make 100ml of 0.2 mol l^{-1} solution.



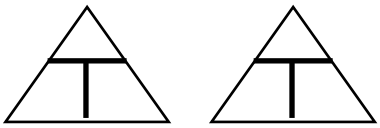
B) Calculate the mass of lithium nitrate ($LiNO_3$) required to make 500 ml of 0.01 mol l^{-1} solution.



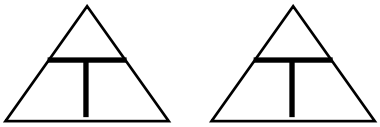
C) Calculate the volume of solution required to make a 0.5 mol l^{-1} solution using 50g of potassium chloride (KCl).



D) Calculate the volume of solution required to make a 0.2 mol l^{-1} solution using 12g of ammonium sulfate ($(NH_4)_2SO_4$)



Using mass and mass



Example: Calculate the mass of carbon dioxide produced when 3.2g of methanol burns completely in oxygen.

$CH_3OH + 1\ 1/2\ O_2 \longrightarrow CO_2 + 2H_2O$

Step 1: Calculate the GFM of methanol

Step 2: Calculate the moles of methanol

Step 3: Use the mole ratio from the balanced equation to find the moles of carbon dioxide

Step 4: Calculate the GFM of carbon dioxide

Step 5: Calculate the mass of carbon dioxide

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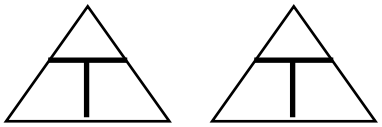
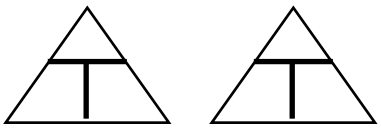
A) Calculate the mass of carbon dioxide produced when 60g of ethane burns completely in oxygen.

$C_2H_6 + 3\ 1/2\ O_2 \rightarrow 2CO_2 + 3H_2O$



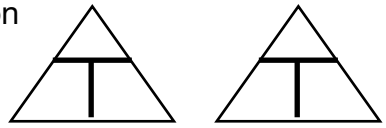
B) Calculate the mass of chlorine required to react with 4.6g of sodium.

$2Na + Cl_2 \rightarrow 2NaCl$



C) Calculate the mass of ethanol burned to produce 160g of carbon dioxide.

$C_2H_5OH + 3\ O_2 \rightarrow 2CO_2 + 3H_2O$



Titrations

Titrations are used to find the concentration of a solution by reaction with a solution of accurately known concentration (standard solution). The end point is indicated by the use of an indicator.

Examples: Calculate the concentration of NaOH when 25 ml of solution is neutralised by 19.5 ml of 0.1 mol l^{-1} HCl.

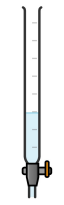
$NaOH + HCl \rightarrow NaCl + H_2O$

Step 1: Calculate the moles of HCl used

Step 2: Use the mole ratio from the balanced equation to find the moles of sodium hydroxide

Step 3: Calculate the concentration of the sodium hydroxide

Calculate the concentration of sodium hydroxide.
$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$



1 mol l^{-1} H_2SO_4

20 ml NaOH

Titration	Start volume (ml)	End volume (ml)	Added volume (ml)
1	0	21.2	21.2
2	21.2	42.0	20.8
3	0	20.8	20.8

Step 1: Calculate the average titre of sulfuric acid

Step 2: Calculate the moles of sulfuric acid used

Step 3: Use the mole ratio from the balanced equation to find the moles of sodium hydroxide

Step 4: Calculate the concentration of sodium hydroxide

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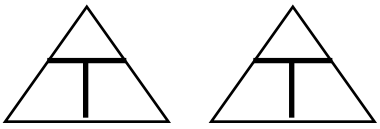
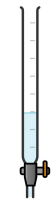
A) Calculate the concentration of sodium hydroxide.



$NaOH + HCl \rightarrow NaCl + H_2O$

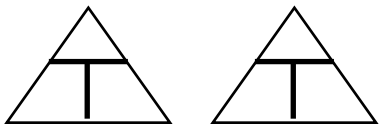


0.5 mol l^{-1} HCl

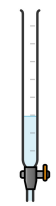
25 ml NaOH

Titration	Start volume (ml)	End volume (ml)	Added volume (ml)
1	0	48.7	48.7
2	0	48.3	48.3
3	0	48.6	48.6

Calculate the concentration of potassium hydroxide.



$3KOH + H_3PO_4 \rightarrow K_3PO_4 + 3H_2O$



0.1 mol l^{-1} H_3PO_4

10 ml KOH

Titration	Start volume (ml)	End volume (ml)	Added volume (ml)
1	0	21.3	21.3
2	21.3	41.8	20.5
3	0	20.7	20.7

Percentage mass calculations

Percentage mass calculations are used to find the percentage of elements present in compounds, usually ores or fertilisers.

% mass = (mass of element present/GFM) x 100%

Examples: Calculate the percentage mass of magnesium in magnesium oxide (MgO)

Calculate the percentage mass of sodium in sodium oxide (Na_2O)

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A)Calculate the percentage mass of iron in iron (III) oxide (Fe_2O_3)

B) Calculate the percentage mass of nitrogen in ammonium phosphate ($(NH_4)_3PO_4$)

C) Calculate the percentage mass of ammonium nitrate (NH_4NO_3)