

# Simple Step-by-Step Guides to Solving Chemistry Problems

## Reacting Masses & Volumes



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# Reacting Masses & Volumes

## Introducing the 'Mole Calculating Frame'

The '*Mole Calculating Frame*', which is both intuitive and easy to use, provides a simple approach to understanding and solving most mole-based problems.



<b>Balanced Equation</b>	$dAX_3$	+	$eZ_2$	$\longrightarrow$	$pAZ$	+	$qZX_2$
<b>Reaction Coefficients</b>	$d$		$e$		$p$		$q$
<b>Ar or Mr</b>	$M_r[AX_3]$		$M_r[Z_2]$		$M_r[AZ]$		$M_r[ZX_2]$
<b>Mass Balance*</b>	$d \times M_r[AX_3]$		$e \times M_r[Z_2]$		$p \times M_r[AZ]$		$q \times M_r[ZX_2]$
<b>Mass (g)</b>	= No. of moles $AX_3 \times M_r[AX_3]$		= No. of moles $Z_2 \times M_r[Z_2]$		= No. of moles $AZ \times M_r[AZ]$		= No. of moles $ZX_2 \times M_r[ZX_2]$
<b>No. of Moles</b>	= Mass of $AX_3/M_r[AX_3]$		= Mass of $Z_2/M_r[Z_2]$		= Mass of $AZ/M_r[AZ]$		= Mass of $ZX_2/M_r[ZX_2]$
<b>No. of Moles (gases only)</b>	= Vol. $(AX_3)/V_m$		= Vol. $(Z_2)/V_m$		= Vol. $(AZ)/V_m$		= Vol. $(ZX_2)/V_m$
<b>Volume (gases only)</b>	= No. of moles $AX_3 \times V_m$		= No. of moles $Z_2 \times V_m$		= No. of moles $AZ \times V_m$		= No. of moles $ZX_2 \times V_m$

\* Mass Balance:  $(d \times M_r[AX_3]) + (e \times M_r[Z_2]) = (p \times M_r[AZ]) + (q \times M_r[ZX_2])$

**Note:** All the items in red are known or can be readily obtained from the balanced equation and relative atomic masses. In calculations additional information will be provided from which all the remaining values can be determined, using the equations provided in the boxes.

## How to use the Mole Calculating Frame

*Step 1:* construct a frame around the balanced chemical equation;

**Step 2:** list the parameters – i.e. reaction coefficients, molar mass, mass, number of moles etc - in the left-hand column;

**Step 3:** insert all known information. Remember you will always be able to determine  $A_r$ ,  $M_r$ , reaction coefficients and undertake a mass balance;

**Step 4:** use question mark(s) to identify the parameters you need to calculate to solve the problem;

**Step 5:** identify which gaps in the framework you can calculate using the known or given information.

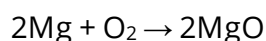
**Units:** mass in grams (g), volume in litres (L) or  $\text{cm}^3$ ,  $A_r/M_r$  in  $\text{g mol}^{-1}$

The Moles Calculating Frame is highly flexible. By changing the parameters in the left-hand column, it can be used to solve all chemical equation based problems involving solids and gases.

**Example 1:** Magnesium metal (Mg) burns with a bright white flame to produce magnesium oxide (MgO). How much MgO could be produced from 2 g of Mg?

**Answer**

**Step 1:** write a balanced equation for the reaction:



Fill in the  $M_r$  of all species and undertake a mass balance {reactants mass =  $(48 + 32) =$  products mass (80)} to both ensure that you have a balanced chemical equation and check that you have calculated the  $M_r$  values correctly.

	2Mg	+	O <sub>2</sub>	→	2MgO
Reaction Coefficients	2		1		1
$M_r$	24		32		40
Mass Balance	48		32		80
Mass					
No. of moles					

**Step 2:** Fill in all the information you have been given in the question:

	2Mg	+	O <sub>2</sub>	→	2MgO
Reaction Coefficients	2		1		1
$M_r$	24		32		40
Mass Balance	48		32		80
Mass	2				?
No. of moles					

**Step 3:** Work out the number of moles of any species for which you are given the mass (i.e. Mg - reactant), using  $n=m/M_r$ . Then use the reaction stoichiometry to determine the number of moles of the unknown, i.e. one (1) mole of Mg will produce one (1) mole MgO:

	2Mg	+	O <sub>2</sub>	→	2MgO
Reaction Coefficients	2		1		1
Mass Balance	48		32		80
Mass	2				?
No. of moles	$2/24 = 0.083$				0.083

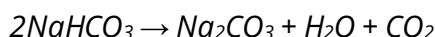
**Step 4:** Since we now know the  $M_r$  and the number of moles of the unknown (MgO), its mass can be calculated i.e. **mass:  $m=n \times M_r$**

	2Mg	+	O <sub>2</sub>	→	2MgO
Reaction Coefficients	2		1		1
$A_r/M_r$	24		32		40
Mass Balance	48		32		80
Mass	2				$0.083 \times 40 = 3.33$
No. of moles	0.083				0.083

Once you are familiar with the process, you don't need a calculation frame, but keep your workings ordered and logical.

**Answer: 3.33 g**

**Example 2:** Baking soda (sodium hydrogen carbonate) thermally degrades to produce sodium carbonate, water and carbon dioxide according to the following equation:



*What mass of sodium hydrogen carbonate is required to produce 10.6 g of sodium carbonate*

**Step 1:** Fill in  $M_r$  values and undertake a mass balance:

	2NaHCO <sub>3</sub>	→	Na <sub>2</sub> CO <sub>3</sub>	+	H <sub>2</sub> O	+	CO <sub>2</sub>
Reaction Coefficients	2		1		1		1
$A_r/M_r$	84		106		18		44
Mass Balance	168		106		18		44
Mass			168		168		
No. of moles							

**Step 2:** Fill in all the information you have been given in the question:

	2NaHCO <sub>3</sub>	→	Na <sub>2</sub> CO <sub>3</sub>	+	H <sub>2</sub> O	+	CO <sub>2</sub>
Reaction Coefficients	2		1		1		

A <sub>r</sub> /M <sub>r</sub>	84	106	18	44
Mass Balance	168	106	18	44
Mass	?	10.6		
No. of moles				

**Step 3:** Work out the number of moles of any species for which you are given the mass (i.e. Na<sub>2</sub>CO<sub>3</sub> - product), using  $n=m/M_r$ . Then use the reaction stoichiometry to determine the number of moles of the unknown, i.e. two (2) moles NaHCO<sub>3</sub> produce one (1) mole of Na<sub>2</sub>CO<sub>3</sub>:

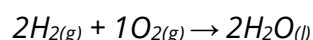
	2NaHCO <sub>3</sub>	→	Na <sub>2</sub> CO <sub>3</sub>	+	H <sub>2</sub> O	+	CO <sub>2</sub>
Reaction Coefficients	2		1		1		1
A <sub>r</sub> /M <sub>r</sub>	84		106		18		44
Mass Balance	168		106		18		44
Mass	?		10.6				
No. of moles	$2 \times 0.1 = 0.2$		$10.6/106 = 0.1$				

**Step 4:** Since we now know the M<sub>r</sub> and the number of moles of the unknown (NaHCO<sub>3</sub>), its mass can be calculated i.e. **mass:  $m = n \times M_r$**

	2NaHCO <sub>3</sub>	→	Na <sub>2</sub> CO <sub>3</sub>	+	H <sub>2</sub> O	+	CO <sub>2</sub>
Reaction Coefficients	2		1		1		1
A <sub>r</sub> /M <sub>r</sub>	84		106		18		44
Mass Balance	168		106		18		44
Mass	$0.2 \times 84 =$ <b>16.8</b>		10.6				
No. of moles	$2 \times 0.1 = 0.2$		$10.6/106 = 0.1$				

**Answer: 16.8 g**

**Example 3:** Use the following equation to answer the questions below:



a) How many moles of oxygen will need to be consumed to produce 8 moles of water?

**Answer**

Construct a mole calculating frame around the balanced equation

	2H <sub>2</sub>	+	O <sub>2</sub>	→	2H <sub>2</sub> O
A <sub>r</sub> /M <sub>r</sub>	2		32		18
Mass Balance	4		32		$2 \times 18 =$ 36
Reaction Coefficients	2		1		1
	8		$8/2 = 4$		8

Thus 1 mole H<sub>2</sub>O is produced from 0.5 mole of O<sub>2</sub>

Therefore, 8 moles are H<sub>2</sub>O are produced from  $0.5 \times 8 =$  **4 moles**

b) What mass of water will be produced from the combustion of 100g of hydrogen?

**Answer**

	2H <sub>2</sub>	+	O <sub>2</sub>	→	2H <sub>2</sub> O
A <sub>r</sub> /M <sub>r</sub>	2		32		18
Mass Balance	4		32		2 x 18 = 36
		36			
Reaction Coefficients	2		1		1
Mass (g)	100				50 x 18 = <b>900</b>
Number of Moles	100/2 = 50				

Number of moles of H<sub>2</sub> in 100 g = mass/M<sub>r</sub> = 100/2 = 50

According to the reaction coefficients 2 moles of H<sub>2</sub> produce 2 moles H<sub>2</sub>O

Therefore, 50 moles of H<sub>2</sub> will produce 50 moles H<sub>2</sub>O

Mass of 50 moles of H<sub>2</sub>O = number of moles x M<sub>r</sub> = 50 x 18 = **900g**

c) *What mass of hydrogen can be combusted by 4 g of oxygen gas?*

**Answer**

	2H <sub>2</sub>	+	O <sub>2</sub>	→	2H <sub>2</sub> O
Reaction Coefficients	2		1		2
A <sub>r</sub> /M <sub>r</sub>	2		32		18
Mass Balance	4		32		2 x 18 = 36
		36			
Mass (g)	0.25 x 2 = <b>0.5</b>		4		
Number of Moles	2 x 0.125 = 0.25		4/32 = 0.125		

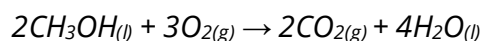
Number of moles in 4 g O<sub>2</sub> = mass/M<sub>r</sub> = 4/32 = 0.125

According to the reaction coefficients 2 moles of H<sub>2</sub> require 1 mole of O<sub>2</sub> for combustion

Therefore 0.125 moles of O<sub>2</sub> can combust 2 x 0.125 = 0.25 moles H<sub>2</sub>

Mass of 0.25 moles H<sub>2</sub> = mass x M<sub>r</sub> = 0.25 x 2 = **0.5g**

**Example 4:** *Use the following equation to answer the questions below:*



a) *How many moles of water will be produced from the combustion of 0.17 moles of CH<sub>3</sub>OH?*

**Answer**

	2CH <sub>3</sub> OH	+	3O <sub>2</sub>	→	2CO <sub>2</sub>	+	4H <sub>2</sub> O
Reaction Coefficients	2		3		2		4
A <sub>r</sub> /M <sub>r</sub>	32		32		44		18
Mass Balance	64		96		88		72
		160				160	

The reaction coefficients tell us that 2 moles CH<sub>3</sub>OH produce 4 moles H<sub>2</sub>O

Thus 1 mole CH<sub>3</sub>OH produces 2 moles H<sub>2</sub>O

Therefore, 0.17 moles CH<sub>3</sub>OH will produce 2 x 0.17 = 0.34 moles H<sub>2</sub>O

b) How many moles of  $O_2$  are needed to burn 2.78 moles of  $CH_3OH$ ?

**Answer**

	$2CH_3OH$	+	$3O_2$	$\rightarrow$	$2CO_2$	+	$4H_2O$
Reaction Coefficients	2		3		2		4
$A_r/M_r$	32		32		44		18
Mass Balance	64		96		88		72
		160				160	
Number of Moles	2.78		$3/2 \times 2.78$				
			<b>= 4.17</b>				

The reaction coefficients tell us that 2 moles  $CH_3OH$  require 3 moles  $O_2$  for combustion

Thus 1 mole  $CH_3OH$  requires  $3/2$  moles  $O_2$  for combustion

Therefore, 2.78 moles  $CH_3OH$  requires  $3/2 \times 2.78 = 4.17$  moles  $O_2$

c) How many moles of  $CO_2$  are produced from the combustion of 1.25 moles of  $CH_3OH$ ?

**Answer**

	$2CH_3OH$	+	$3O_2$	$\rightarrow$	$2CO_2$	+	$4H_2O$
Reaction Coefficients							
$A_r/M_r$	32		32		44		18
Mass Balance	64		96		88		72
		160				160	
Reaction Coefficients	2		3		2		4
Number of Moles	1.25		1.875		<b>1.25</b>		2.50

The reaction coefficients tell us that 2 moles  $CO_2$  are produced from the combustion of 2 moles  $CH_3OH$

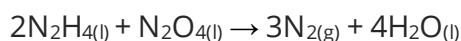
Thus 1 mole  $CO_2$  is produced from the combustion of 1 mole of  $CH_3OH$

Therefore, 1.25  $CO_2$  are produced from the combustion of 1.25 moles  $CH_3OH$

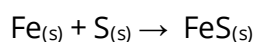


## Practice Problems

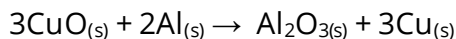
a. Determine the number of moles of  $N_2O_4$  needed to react completely with 3.62 moles of  $N_2H_4$  for the reaction:



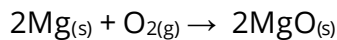
b. What mass of iron (II) sulfide can be formed from 14.0 g of sulfur?



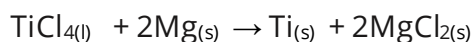
c. What mass of aluminum will be needed to react with 10 g of  $CuO$ , and what mass of  $Al_2O_3$  will be produced?



- d. What mass of magnesium oxide is made when 250 g of oxygen reacts with excess magnesium?



- e. Titanium(IV) chloride can be converted to titanium by reacting it with an excess of magnesium.

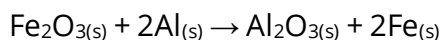


What mass of titanium could theoretically be obtained from 37.98 kg of titanium(IV) chloride?

- f. What mass of potassium hydrogen carbonate is needed to make 100 g of potassium carbonate on thermal decomposition?

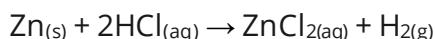


- g. The Thermite Reaction below forms the basis of thermite welding often used to join rail tracks.

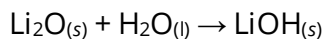


What mass of aluminium is required to produce 7g of iron?

- h. What mass of zinc chloride would be formed by reacting 10 g of zinc with dilute hydrochloric acid?

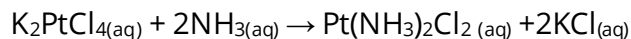


- i. Lithium oxide is a drying agent used on the space shuttle. What mass of water could be removed by 65g of lithium oxide?



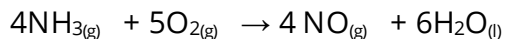
- j. Cisplatin is an anti-cancer agent prepared as follows:





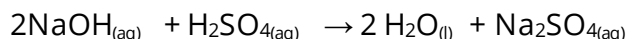
How many grams of cisplatin can be obtained from 10.0 g of  $\text{K}_2\text{PtCl}_4$ ?

k. Ammonia ( $\text{NH}_3$ ) combusts in air to produce nitrogen dioxide and water according to the following equation:



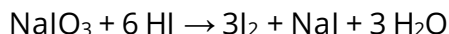
How many moles and how many grams of oxygen ( $\text{O}_2$ ) are needed to react with 56.8 grams of ammonia by this reaction?

l. Using the following equation:



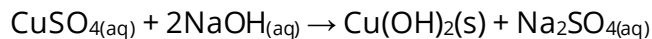
How many grams of sodium sulfate will be formed if you start with 200 grams of sodium hydroxide and you have an excess of sulfuric acid?

m. Using the following equation:



Calculate the number of moles and the number of grams of iodine ( $\text{I}_2$ ) that can be made this way from 8.2 grams of  $\text{NaIO}_3$ .

n. A solution of copper sulphate reacts with sodium hydroxide solution to produce a precipitate of copper hydroxide according to the following equation:

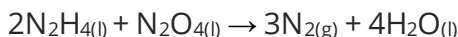


What mass of sodium hydroxide would be needed to convert 15.95 g of copper sulphate to copper hydroxide and what mass of copper hydroxide would be produced?

**Answers are given on the next page.**

## ? Practice Problem Answers

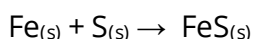
- a. Determine the number of moles of  $\text{N}_2\text{O}_4$  needed to react completely with 3.62 moles of  $\text{N}_2\text{H}_4$  for the reaction:



*Answer:*

The balanced chemical equation tells us that 2 moles of  $2\text{N}_2\text{H}_4$  react with 1 mole  $\text{N}_2\text{O}_4$   
Thus 3.62 moles of  $\text{N}_2\text{H}_4$  will require  $3.62/2 = \mathbf{1.81 \text{ moles of } \text{N}_2\text{O}_4}$

- b. What mass of iron (II) sulfide can be formed from 14.0 g of sulfur?



*Answer:*

	$\text{Fe}(\text{s})$	+	$\text{S}(\text{s})$	$\rightarrow$	$\text{FeS}(\text{s})$
Reaction Coefficients	1		1		1
A <sub>r</sub> /M <sub>r</sub>	56		32		88
Mass Balance		88			88
Mass	$0.438 \times 56 = 24.5\text{g}$		14		$0.438 \times 88 = \mathbf{38.5}$
No. of moles	0.438		$14/32 = 0.438$		

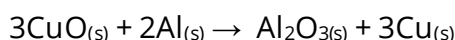
Number of moles in 14g of S =  $14/32 = 0.438$

According to the reaction coefficients, 1 mole of Fe reacts with 1 mole of S

Therefore 0.438 moles of S can produce 0.438 moles of FeS

Mass of 0.438 moles of FeS = number of moles  $\times$  M<sub>r</sub> =  $0.438 \times 88 = \mathbf{38.5g}$

- c. What mass of aluminum will be needed to react with 10 g of CuO, and what mass of  $\text{Al}_2\text{O}_3$  will be produced?



*Answer:*

	$3\text{CuO}$	+	$2\text{Al}$	$\rightarrow$	$\text{Al}_2\text{O}_3$	+	$3\text{Cu}$
Reaction Coefficients	3		2		1		3
A <sub>r</sub> / M <sub>r</sub>	79.5		27		102		63.5
Mass Balance	238.5		54		102		190.5
		292.5				292.5	
Mass	10				$0.042 \times 102 = \mathbf{4.28}$		
					<b>g</b>		
No. of moles	$10/79.5$ $= 0.126$				$0.126/3 = 0.042$		

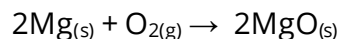
Number of moles in 10 g of CuO =  $10/79.5 = 0.126$

According to the reaction coefficients, 3 moles of CuO produce 1mole of  $\text{Al}_2\text{O}_3$ .

Therefore, the number of moles of  $\text{Al}_2\text{O}_3$  produced from 0.126 moles of CuO =  $0.126/3 = 0.042$

Mass of 0.042 moles of  $\text{Al}_2\text{O}_3$  = number of moles  $\times$  M<sub>r</sub> =  $0.042 \times 102 = \mathbf{4.28 \text{ g}}$

- d. What mass of magnesium oxide is made when 250 g of oxygen reacts with excess magnesium?

**Answer:**

	$2\text{Mg}_{(s)}$	+	$\text{O}_{2(g)}$	$\rightarrow$	$2\text{MgO}_{(s)}$
Reaction Coefficients	2		1		2
A./Mr	24		32		40
Mass Balance	48		32		80
		80			80
Mass			250		$15.6 \times 40 = 625\text{g}$
No. of moles			$250/32 = 7.8$		$2 \times 7.8 = 15.6$

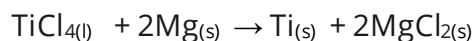
Number of moles  $\text{O}_2$  in 250g =  $250/32 = 7.8$

According to the reaction coefficients, one mole of  $\text{O}_2$  produces 2 moles of MgO

Therefore, the number of moles of MgO produced from 7.8 moles  $\text{O}_2 = 7.8 \times 2 = 15.6$

Mass of 15.6 moles MgO = number of moles  $\times M_r = 15.6 \times 40 = 625\text{ g}$

- e. Titanium(IV) chloride can be converted to titanium by reacting it with an excess of magnesium.



What mass of titanium could theoretically be obtained from 37.98 kg of titanium(IV) chloride?

**Answer:**

	$\text{TiCl}_4$	+	$2\text{Mg}$	$\rightarrow$	$\text{Ti}$	+	$2\text{MgCl}_2$
Reaction Coefficients							
A./Mr	190		24		48		95
Mass Balance	190		48		48		190
		138				138	
Mass (g)	37980				$199.9 \times 48 = 9595$		
No. of moles	$37980/190 = 199.9$				200		

Number of moles  $\text{TiCl}_4$  in 37.48 kg =  $37980/190 = 199.9$

According to the reaction coefficients, 1 mole of  $\text{TiCl}_4$  generates 1 mole Ti

Therefore, the number of moles of Ti generated from 199.9 moles  $\text{TiCl}_4 = 199.9$  moles

Mass of 200 moles of Ti = number of moles  $\times M_r = 199.9 \times 48 = 9595\text{ g} = 9.595\text{ kg}$

- f. What mass of potassium hydrogen carbonate is needed to make 100 g of potassium carbonate on thermal decomposition?

**Answer:**

	$2\text{KHCO}_3$	$\rightarrow$	$\text{K}_2\text{CO}_3$	+	$\text{H}_2\text{O}$	+	$\text{CO}_2$
Reaction Coefficients	2		1		1		1
A./Mr	100				18		44
Mass Balance	200		138		18		44

		200		200
Mass (g)	$1.45 \times 100 = 145$		100	
No. of moles	$0.725 \times 2 = \mathbf{1.45}$		$100/138 = 0.725$	

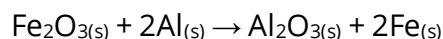
Number of moles of  $K_2CO_3$  in 100g =  $100/138 = 0.73$

According to the reaction coefficients 1 mole  $K_2CO_3$  is produced from 2 moles of  $KHCO_3$

Therefore 0.725 moles of  $K_2CO_3$  would be generated from  $0.725 \times 2 = 1.46$  moles of  $KHCO_3$

Mass of 1.46 moles of  $KHCO_3$  = number of moles  $\times M_r = 1.45 \times 100 = \mathbf{145\text{ g}}$

- g. The Thermite Reaction below forms the basis of thermite welding often used to join rail tracks.



What mass of aluminium is required to produce 7g of iron?

*Answer:*

	$Fe_2O_3$	+	$2Al$	$\rightarrow$	$Al_2O_3$	+	$2Fe$
Reaction Coefficients	1		2		1		2
A <sub>r</sub> / M <sub>r</sub>	160		27		102		56
Mass Balance	160		54		102		112
		21				214	
		4					
Mass (g)			$0.125 \times 27 = \mathbf{3.375}$				7
No. of moles			0.125				$7/56 = 0.125$

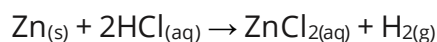
Number of moles Fe in 7 g =  $7/56 = 0.125$

According to the reaction coefficients, 2 moles of Fe are generated from 2 moles of Al

Therefore the number of moles of Al required to produce 0.125 moles of Fe = 0.125

Mass of 0.125 moles of Al = number of moles  $\times M_r = 0.125 \times 27 = \mathbf{3.375\text{ g}}$

- h. What mass of zinc chloride would be formed by reacting 10 g of zinc with dilute hydrochloric acid?



*Answer:*

	Zn	+	$2HCl$	$\rightarrow$	$ZnCl_2$	+	$H_2$
Reaction Coefficients	1		2		1		1
A <sub>r</sub> / M <sub>r</sub>	65		36.5		136		2
Mass Balance	65		73		136		2
		138				138	
Mass (g)	10				$0.154 \times 136 = \mathbf{20.9}$		
No. of moles	$10/65 = 0.154$				0.154		

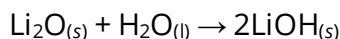
Number of moles of Zn in 10 g =  $10/65 = 0.154$

According to the reaction coefficients, 1 mole of Zn produces 1 mole  $ZnCl_2$

Therefore, the number of moles of  $ZnCl_2$  generated from 0.154 moles of Zn = 0.154

Mass of 0.154 moles of  $ZnCl_2$  = number of moles  $\times M_r = 0.154 \times 136 = \mathbf{20.9\text{ g}}$

- i. Lithium oxide is a drying agent used on the space shuttle. What mass of water could be removed by 65g of lithium oxide?



*Answer:*

	$\text{Li}_2\text{O}$	+	$\text{H}_2\text{O}$	→	$2\text{LiOH}$
Reaction Coefficients	1		1		2
A/Mr	30		18		24
Mass Balance	30		18		
		48			48
Mass (g)	65		$2.17 \times 18 = 39$		
No. of moles	$65/30 = 2.17$		2.17		

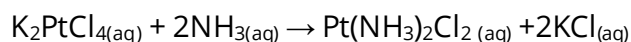
Number of moles in 65 g of  $\text{Li}_2\text{O} = 65/30 = 2.17$

According to the reaction coefficients, 1 mole of  $\text{Li}_2\text{O}$  reacts with 1 mole of  $\text{H}_2\text{O}$

Therefore 2.17 moles  $\text{Li}_2\text{O}$  will react with 2.17 moles of  $\text{H}_2\text{O}$

Mass of 2.2 moles of  $\text{H}_2\text{O} = \text{number of moles} \times M_r = 2.17 \times 18 = \mathbf{39 \text{ g}}$

- j. Cisplatin is an anti-cancer agent prepared as follows:



How many grams of cisplatin can be obtained from 10.0 g of  $\text{K}_2\text{PtCl}_4$ ?

*Answer:*

	$\text{K}_2\text{PtCl}_4$	+	$2\text{NH}_3$	→	$\text{Pt}(\text{NH}_3)_2\text{Cl}_2$	+	$2\text{KCl}$
Reaction Coefficients	1		2		1		2
A/ M <sub>r</sub>	415		17		300		74.5
Mass Balance	417		34		300		149
		449				449	
Mass (g)	10				<b>7.24</b>		
No. of moles	$10/417 = 0.024$				0.024		

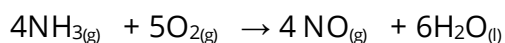
Number of moles of  $\text{K}_2\text{PtCl}_4$  in 10g =  $10/417 = 0.024$

According to the equation, one mole of  $\text{K}_2\text{PtCl}_4$  generates one mole of  $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$

Therefore, 0.024 moles of  $\text{K}_2\text{PtCl}_4$  generates 0.024 moles of  $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$

Mass of 0.024 moles of  $\text{Pt}(\text{NH}_3)_2\text{Cl}_2 = \text{number of moles} \times M_r = 0.024 \times 302 = \mathbf{7.24 \text{ g}}$

- k. Ammonia ( $\text{NH}_3$ ) combusts in air to produce nitrogen dioxide and water according to the following equation:



How many moles and how many grams of oxygen ( $\text{O}_2$ ) are needed to react with 56.8 grams of ammonia by this reaction?

*Answer:*



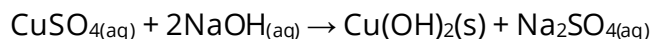
Number of moles in 8.2 g of  $\text{NaIO}_3 = \text{mass}/M_r = 8.2/198 = 0.0414$

According to the reaction coefficients, 1 mole of  $\text{NaIO}_3$  produces 3 moles  $\text{I}_2$

Therefore, 0.0414 moles of  $\text{NaIO}_3$  will produce  $3 \times 0.0414 = 0.124$  moles of  $\text{I}_2$

Mass of 0.124 moles of  $\text{I}_2 = \text{number of moles} \times M_r = 0.124 \times 254 = \mathbf{31.6 \text{ g}}$

n. A solution of copper sulfate reacts with sodium hydroxide solution to produce a precipitate of copper hydroxide according to the following equation:



What mass of sodium hydroxide would be needed to convert 15.95 g of copper sulphate to copper hydroxide and what mass of copper hydroxide would be produced?

*Answer:*

	$\text{CuSO}_4$	+	$2\text{NaOH}$	$\rightarrow$	$\text{Cu}(\text{OH})_2$	+	$\text{Na}_2\text{SO}_4$
Reaction Coefficients	1		2		1		1
A/ $M_r$	159.5		40		97.5		142
Mass Balance	159.5		80		97.5		142
		239.5				239.5	
Mass (g)	15.95		$0.2 \times 40 = \mathbf{8}$		$0.1 \times 97.5 = \mathbf{9.75}$		14.2
No. of moles	$159.5/159.5 = 0.1$		0.2		0.1		0.1

Number of moles in 15.95 g of  $\text{CuSO}_4 = \text{mass}/M_r = 15.95/159.5 = 0.1$

According to the reaction coefficients, 1 mole of  $\text{CuSO}_4$  reacts with 2 moles of  $\text{NaOH}$  to produce 1 mole of  $\text{Cu}(\text{OH})_2$

Therefore, 0.1 moles  $\text{CuSO}_4$  reacts with 0.2 moles of  $\text{NaOH}$  to produce 0.1 mole of  $\text{Cu}(\text{OH})_2$

Mass of 0.2 moles  $\text{NaOH} = \text{number of moles} \times M_r = 0.2 \times 40 = \mathbf{8 \text{ g}}$

Mass of 0.1 moles  $\text{Cu}(\text{OH})_2 = \text{number of moles} \times M_r = 0.1 \times 97.5 = \mathbf{9.75 \text{ g}}$