

Atomic weight: H=1, C=12, N=14, O=16, F=19, Ne=20.2, Al=27, P=31, S=32, K=39, Cl=35.5, Ar=40, Cr=52, Cu=63.55, Ag=108 amu

Ex. 1: For the reaction of 50.0 g of N₂ with H₂, determine the theoretical yield of ammonia. If 49.6 g of NH₃ was actually produced, calculate the percent yield for the reaction.

$$\text{Mw N}_2 = 2 \times 14 = 28 \text{ amu, Mw NH}_3 = 14 + (3 \times 1) = 17 \text{ amu}$$

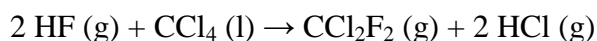


$$50 \times 2 \times 17$$

$$\text{Theoretical Yield} = \frac{\quad}{28} = \mathbf{60.71 \text{ g NH}_3}$$

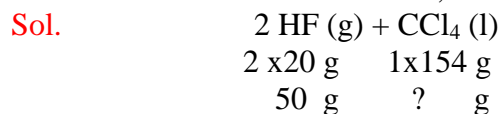
$$\text{Percent Yield} = \frac{\text{Actual yield}}{\text{Theoretical Yield}} \times 100 = \frac{49.6 \text{ g}}{60.71 \text{ g}} \times 100 = \mathbf{81.7\%}$$

Ex. 2: Chlorofluorocarbons which has the formula CCl₂F₂ and can be prepared as follows:



Calculate the mass of CCl₄ necessary to react completely with 50.0 g of HF.

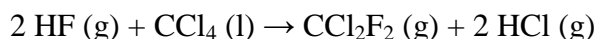
$$\text{Mw HF} = 1 + 19 = 20 \text{ amu, Mw CCl}_4 = (1 \times 12) + (4 \times 35.5) = 154 \text{ amu}$$



$$50 \times 154$$

$$? = \frac{\quad}{2 \times 20} = \mathbf{192.5 \text{ g CCl}_4}$$

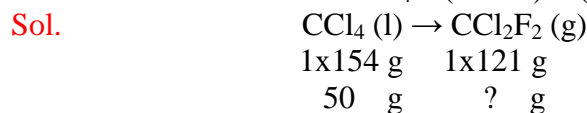
Ex. 3: Chlorofluorocarbons which has the formula CCl₂F₂ and can be prepared as follows:



Calculate the mass of CCl₂F₂ produced when 50.0 g of CCl₄ reacts completely.

$$\text{Mw CCl}_2\text{F}_2 = (1 \times 12) + (2 \times 35.5) + (2 \times 19) = 121 \text{ amu,}$$

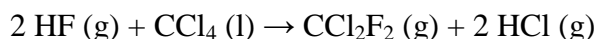
$$\text{Mw CCl}_4 = (1 \times 12) + (4 \times 35.5) = 154 \text{ amu}$$



$$50 \times 121$$

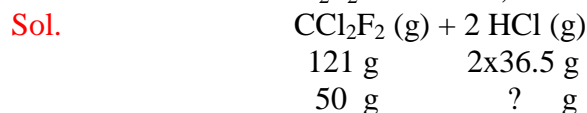
$$? = \frac{\quad}{154} = \mathbf{39.29 \text{ g CCl}_2\text{F}_2}$$

Ex. 4: Chlorofluorocarbons which has the formula CCl₂F₂ and can be prepared as follows:



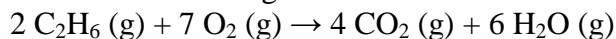
Calculate the mass of HCl produced when 50.0 g of CCl₂F₂ is produced.

$$\text{Mw CCl}_2\text{F}_2 = 121 \text{ amu, Mw HCl} = 1 + 35.5 = 36.5 \text{ amu}$$

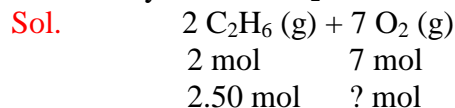


$$? = \frac{50 \times 2 \times 36.5}{121} = \mathbf{30.17 \text{ g HCl}}$$

Ex. 5: Consider the following:

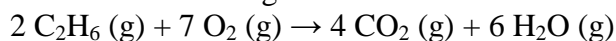


How many moles of O₂ will react with 2.50 moles of C₂H₆?

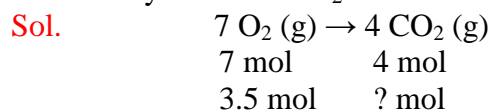


$$? = \frac{2.50 \times 7}{2} = \mathbf{8.75 \text{ mol O}_2}$$

Ex. 6: Consider the following:

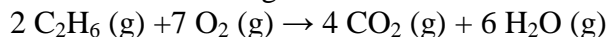


How many moles of CO₂ form when 3.50 moles of O₂ completely react?

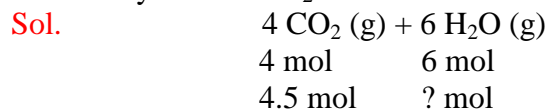


$$? = \frac{3.5 \times 4}{7} = \mathbf{2.0 \text{ mol CO}_2}$$

Ex. 7: Consider the following:

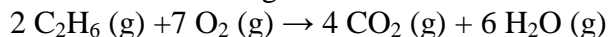


How many moles of H₂O form when 4.50 moles of CO₂ form?

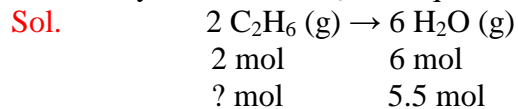


$$? = \frac{4.5 \times 6}{4} = \mathbf{6.75 \text{ mol H}_2\text{O}}$$

Ex. 8: Consider the following:

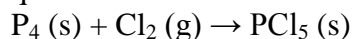


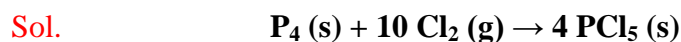
How many moles of C₂H₆ are required to produce 5.50 moles of H₂O?



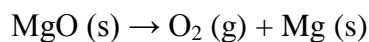
$$? = \frac{5.5 \times 2}{6} = \mathbf{1.83 \text{ mol C}_2\text{H}_6}$$

Ex. 9: Balance the equation:

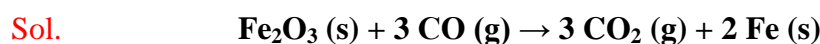
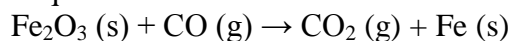




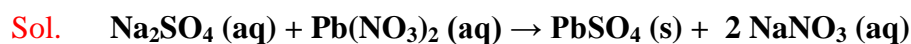
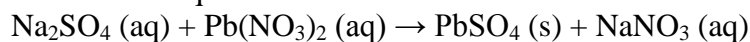
Ex. 10: Balance the equation:



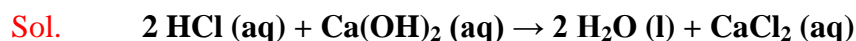
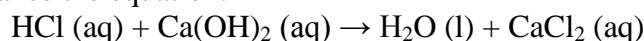
Ex. 11: Balance the equation:



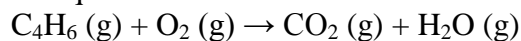
Ex. 12: Balance the equation:



Ex. 13: Balance the equation:

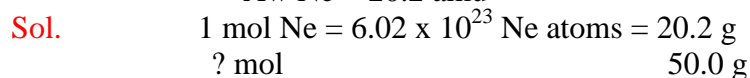


Ex. 14: Balance the equation:



Ex. 15: How many moles of Ne are in 50.0 g Ne?

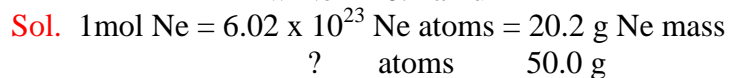
Aw Ne = 20.2 amu



$$? = \frac{50.0 \times 1}{20.2} = \mathbf{2.48 \text{ mol Ne}}$$

Ex. 16: How many Ne atoms are in 50.0 g of Ne?

Aw Ne = 20.2 amu



$$? = \frac{50.0 \times 6.02 \times 10^{23}}{20.2} = \mathbf{14.9 \times 10^{23} \text{ Ne atoms}}$$

Ex. 17: How many moles of CO₂ are in 25.0 g of CO₂?

$$\text{Mw: CO}_2 = 12 + (2 \times 16) = 44 \text{ amu}$$

Sol. 1 mol CO₂ = 6.02 x 10²³ CO₂ molecules = 44 g CO₂ mass
? mol 25.0 g

$$? = \frac{25.0 \times 1}{44} = \mathbf{0.57 \text{ mol of CO}_2}$$

Ex. 18: How many CO₂ molecules are in 25.0 g of CO₂?

$$\text{Mw: CO}_2 = 12 + (2 \times 16) = 44 \text{ amu}$$

Sol. 1 mol CO₂ = 6.02 x 10²³ CO₂ molecules = 44 g CO₂ mass
? molecules 25.0 g CO₂

$$? = \frac{25.0 \times 6.02 \times 10^{23}}{44} = \mathbf{3.42 \text{ CO}_2 \text{ molecules}}$$

Ex. 19: How many oxygen atoms are in 25.0 g of CO₂?

$$\text{Mw: CO}_2 = 12 + (2 \times 16) = 44 \text{ amu}$$

Sol. 1 mol CO₂ = 6.02 x 10²³ CO₂ molecules = 44 g CO₂ mass

$$1 \text{ mol CO}_2 = 2 \text{ mol O} = 2 \times 6.02 \times 10^{23} \text{ O atoms} = 44 \text{ g CO}_2$$

? O atoms 25.0 g

$$? = \frac{25.0 \times 2 \times 6.02 \times 10^{23}}{44} = \mathbf{6.84 \times 10^{23} \text{ O atoms}}$$

Ex. 20: Glucose has the molecular formula C₆H₁₂O₆. How many grams of carbon are in 39.0 g of glucose?

$$\text{Mw C}_6\text{H}_{12}\text{O}_6 = (6 \times 12) + 12 + (6 \times 16) = 180 \text{ amu}$$

Sol. 180 g mass C₆H₁₂O₆ = 1 mol C₆H₁₂O₆ = 6 mol C = 6 x 12 g C mass
39 g ? g C

$$? = \frac{6 \times 12 \times 39}{180} = \mathbf{15.6 \text{ g C}}$$

Ex. 21: How many grams of nitrogen are needed to completely react with 0.525 g of hydrogen in the formation of ammonia?

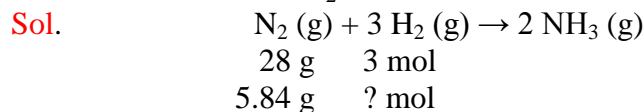
$$\text{Mw N}_2 = 2 \times 14 = 28 \text{ amu, Mw H}_2 = 2 \times 1 = 2 \text{ amu}$$

Sol. N₂ (g) + 3 H₂ (g) → 2 NH₃ (g)
28 g 3x2 g
? g 0.525 g

$$? = \frac{28 \times 0.525}{3 \times 2} = \mathbf{2.45 \text{ g N}_2}$$

Ex. 22: How many moles of H₂ are needed to combine with 5.84 g of N₂ in the formation of ammonia?

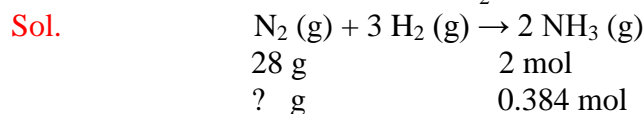
$$\text{Mw N}_2 = 2 \times 14 = 28 \text{ amu}$$



$$? = \frac{5.84 \times 3}{28} = \mathbf{0.62 \text{ mol H}_2}$$

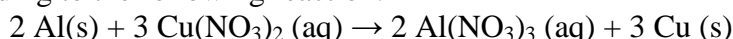
Ex. 23: How many grams of N₂ will be needed to produce 0.384 moles of NH₃?

$$\text{Mw N}_2 = 2 \times 14 = 28 \text{ amu}$$

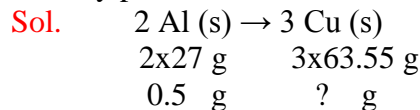


$$? = \frac{28 \times 0.384}{2} = \mathbf{5.376 \text{ g N}_2}$$

Ex. 24: According to the following reaction:



Determine the theoretical yield of Cu for 0.5 g of Al reactant. If 1.53 g of Cu was actually produced, calculate the percent yield for the reaction.



$$? = \frac{0.5 \times 3 \times 63.55}{2 \times 27} = \mathbf{1.77 \text{ g Cu Theoretical Yield}}$$

$$\text{Percentage Yield\%} = \frac{1.53}{1.77} \times 100 = \mathbf{86.4\%}$$

Ex. 25: How much glucose is required to prepare 200 mL of 0.150 M of C₆H₁₂O₆?

$$\text{Mw C}_6\text{H}_{12}\text{O}_6 = (6 \times 12) + 12 + (6 \times 16) = 180 \text{ amu}$$

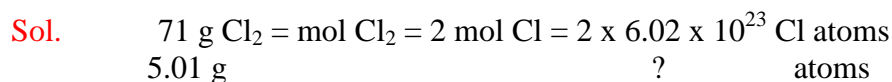
Sol.

$$\text{M (molarity)} = \frac{\text{Moles of solute (mol)}}{\text{Volume of solution (L)}} = \frac{m_{\text{(solute)}} \text{ (g)}}{\text{MM}_{\text{(solute)}} \text{ (g/mol)} \times V_{\text{(solution)}} \text{ (L)}}$$

$$m = M \times \text{MM} \times V = 0.150 \times 180 \times 200 \times 10^{-3} = \mathbf{5.4 \text{ g C}_6\text{H}_{12}\text{O}_6}$$

Ex. 26: How many Cl atoms are there in 5.01g of elemental Cl?

$$\text{Mw Cl}_2 = 2 \times 35.5 = 71 \text{ amu}$$



Ex. 33: Find concentration in molar of 20.1g of NaOH in 300 mL volume of solution.

$$\text{Mw NaOH} = 23 + 16 + 1 = 40 \text{ amu}$$

Sol.

$$M \text{ (molarity)} = \frac{\text{Moles of solute (mol)}}{\text{Volume of solution (L)}} = \frac{m_{\text{(solute)}} \text{ (g)}}{\text{MM}_{\text{(solute)}} \text{ (g/mol)} \times V_{\text{(solution)}} \text{ (L)}}$$

$$M = \frac{20.1}{40 \times 300 \times 10^{-3}} = \mathbf{1.675 \text{ M or (mol/L)}}$$

Ex. 34: How many grams of Cl atoms are needed to combine with 24.4 g of Si atoms to make SiCl₄?

$$\text{Aw Si} = 28 \text{ amu, Aw Cl} = 35.5 \text{ amu}$$

Sol. 1 mol Si = 28 g Si mass = 4 mol Cl = 4 x 35.5 g Cl atom mass

$$? = \frac{24.4 \text{ g} \times 4 \times 35.5}{28} = \mathbf{123.7 \text{ g Cl atom mass}}$$

Ex. 35: What is the percent yield of the reaction if 32.8 g of C₅H₁₂O is obtained from reaction of 26.3 g of C₄H₈ with sufficient methanol?



$$\text{Mw C}_4\text{H}_8 = (4 \times 12) + (8 \times 1) = 56 \text{ amu}$$

$$\text{Mw C}_5\text{H}_{12}\text{O} = (5 \times 12) + (12 \times 1) + 16 = 88 \text{ amu}$$

Sol. C₄H₈ (g) + CH₃OH (l) → C₅H₁₂O (l)

$$\begin{array}{ccc} 56 \text{ g} & & 88 \text{ g} \\ 26.3 \text{ g} & & ? \text{ g} \end{array}$$

$$? = \frac{26.3 \times 88}{56} = \mathbf{41.33 \text{ g C}_5\text{H}_{12}\text{O mass (Theoretical yield)}}$$

$$\text{Percent yield\%} = \frac{\text{Actual Yield}}{\text{Theoretical yield}} \times 100 = \frac{32.8}{41.33} \times 100 = 79.36\%$$

$$V = \frac{0.20 \times 1}{0.250 \times 1} = 0.03 \text{ L} = \mathbf{30 \text{ mL CaCl}_2 \text{ is needed}}$$

Ex.36: How many grams of CO₂ (theoretical yield) will be formed when a mixture containing 1.93 g C₂H₄ and 5.92 g O₂ is burned? How many grams of which reactant will remain unreacted?

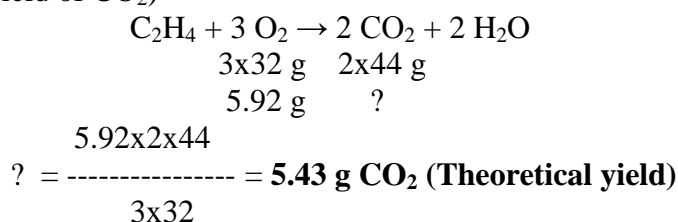
$$\text{Mw C}_2\text{H}_4 = 28, \text{Mw O}_2 = 32, \text{Mw CO}_2 = 44 \text{ amu}$$

Sol. C₂H₄ + 3 O₂ → 2 CO₂ + 2 H₂O

Finding Limiting Reactant: L.R.

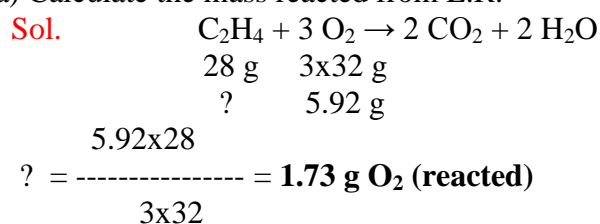
	Mass	1.93 g C ₂ H ₄ react with	5.92 g O ₂
Convert to mol.	n	1.93/28 mol	5.92/32 mol
	Mol	0.069 mol	0.185 mol
Divide by coefficient		0.069/1	0.185/3
Smallest # is L.R.		0.0689	<u>0.0617</u>

O₂ is the limiting reactant. Use the amount of L.R. to calculate the product (theoretical yield of CO₂)



Mass of remain unreacted C₂H₄ (in Excess):

a) Calculate the mass reacted from L.R.



b) Mass of remain unreacted = mass in reaction - mass reacted

Mass of remain unreacted = 1.93 – 1.73 = **0.20 g C₂H₄ unreacted**

Ex.37: What is the empirical formula of a compound composed of 43.7% P and 56.3% O? n = m/MM

Sol.

	P	O
Mass	43.7 g	56.3 g
a) Convert mass to moles	43.7/31	56.3/16
mol	<u>1.41mol</u>	3.52 mol
b) Divide by smallest #	1.41/1.41 1	3.52/1.41 2.5
c) Convert to whole #		
Multiply by 2 to obtain:	2x1=2	2x2.5=5
d) Empirical Formula	(PO _{2.5}) ₂	→ P₂O₅

Ex.38: What is the molecular formula of the compound which has a molecular mass 92.0 and empirical formula is NO₂?

$$\text{Mw NO}_2 = 46 \text{ amu}$$

Sol.

Molecular Mass

a) Find the Repeated Factor (R.F.) = -----

Mass of the Empirical Formula

Repeated Factor is the number of times the empirical formula repeated in the compound.

$$\frac{92.0}{46.0}$$

R.F. = ----- = 2 (whole #)

$$\frac{92.0}{46.0}$$

b) Multiply Empirical Formula (subscript of element in the formula) by R.F. to get Molecular Formula



Ex 39: Calculate the percentage of Cr in $K_2Cr_2O_7$.

Sol. $\%Cr = \frac{\# \text{ Mol. of Cr in formula} \times \text{MM Cr}}{\text{MM of the substance } K_2Cr_2O_7} \times 100$

$$\%Cr = \frac{2 \times 52}{2 \times 39 + 2 \times 52 + 7 \times 16} \times 100 = \frac{104 \times 100}{294} = 35.4\% \text{ Cr (w/w)}$$

Ex.40: What is the molecular formula of the substance which has a molar mass of 62.1 g/mol and is composed of 38.7% C, 9.7% H, and the rest of O?

Sol. Find %O;

$$\%O = 100 - (38.7 + 9.7) = 51.6\% \text{ O}$$

	C	H	O
Convert mass to mol	38.7/12	9.7/1	51.6/16
Mole	3.225	9.7	3.225
Divide by smallest #	1	3	1
Empirical Formula:	CH_3O		

Molecular Formula: Find **R.F.** = $\frac{62.1}{12+3+16} = 2$ (multiply by E.F.)

The Molecular Formula: $(CH_3O)_2 \rightarrow C_2H_6O_2$
