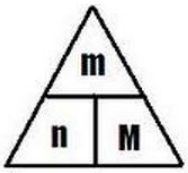
The mole and molar mass ➢ There are 6.02 x 1023 particles in one mole ➢ Molar mass is calculated from PT ➢ # of particles → Mole → Mass and Mass → Mole → # of Particles **Percentage composition** ➢ (Element mass ÷ Compound mass) x 100% **Empirical and Molecular Formula** ➢ Determine simplest formula from % composition, grams of reactants, or moles ➢ Calculate molecular formula from simplest formula and molar mass	**Stoichiometry** ➢ grams A → moles A → moles B → grams B ➢ use mole ratio to find moles of sub. A to sub. B in bal eq'n **Limiting reagents** ➢ Actual/Ideal chart for limiting reagents ➢ The limiting reagent is the "given quantity" ➢ Shortcut method of determining limiting reagent **Percentage yields** ➢ Percentage yield = actual/theoretical x100% ➢ Actual yield is given, theoretical is calculated ➢ 4 reasons why actual yield falls short

Important equations:



M = Molar Mass
n = Moles
m = Mass

$$\text{PERCENT COMPOSITION} = \frac{\text{(TOTAL MASS OF ELEMENT PRESENT)}}{\text{(MOLECULAR MASS)}} \times 100$$

$$\% \text{ Yield} = 100 \times \frac{\text{Actual Yield}}{\text{Theoretical Yield}}$$

1. Calculate the following:
   a) How many moles are present in 8.5 g of magnesium nitrate, $Mg(NO_3)_2$?
   b) How many atoms are there in 8.5 g of $Mg(NO_3)_2$?
   c) How many moles are there in 4.20×10^{21} molecules of methane?
   d) What is the mass of 1.0×10^{23} molecules of water?

2. Titanium reacts with oxygen to produce titanium oxide, the pigment that gives paint and sunscreen a white colour. .
   a) If 15.6 g of titanium reacts with oxygen to form 20.0 g of titanium oxide, calculate the mass of oxygen that reacted. What chemistry law are you using?
   b) Calculate the percent composition of titanium oxide.
   b) How much titanium oxide can be produced from 500 g of titanium and unlimited oxygen? What law are you using to solve this?

3. What is the percent composition of: a) sodium carbonate (Na_2CO_3)? b) aluminum oxide (Al_2O_3)?

4. What is the empirical formula of a compound that is:
   a) 30.4% N, 69.6% O (by mass)
   b) 43.6% P, 56.4% O (by mass)

5. What is the molecular formula of a compound with molar mass 60.0 g and composed of 39.97% C, 6.73% H, and 53.30% O (by mass)?

6. A certain compound has the following percent composition: C - 57.1 %, H - 4.8%, and O- 38.1 %. If the molar mass is 126 g, what is the molecular formula?

7. When 25.0 g of a certain organic compound containing C, H and O is subjected to combustion analysis, 27.8 g of CO_2 and 19.9 g of H_2O are recovered. Determine the empirical formula of the compound.

8. How many grams of lead (II) chloride will be produced when 6.7 g of lead (II) nitrate react with excess hydrochloric acid to form nitric acid and lead (II) chloride?

9. A reaction involved in the production of iron from iron ore is:

$$Fe_2O_3\,(s) + CO\,(g) \longrightarrow Fe\,(s) + CO_2\,(g)$$

a) How many kilograms of CO must react to produce 3.50 kg of Fe?
b) What mass of CO_2 would be produced?

10. a) What is the maximaum amount of iron (III) oxide than can be produced when 255 g of iron (II) sulfide are reacted with 71.4 g of oxygen gas in a closed container to produce iron (III) oxide and sulfur dioxide gas?
b) What mass of the excess reactant remains after the reaction?

11. a) What is the maximum theoretical yield of carbon dioxide when 8.50 g of methane (CH_4) react with 31.8 g of oxygen gas to form carbon dioxide and water?
b) If 20.5 g of carbon dioxide is actually produced i nthe reaction (actual yield), what is the percentage yield?

12. Calculate the mass of aluminum sulfate formed when 6.71 g of Al react with 12.95 g of H_2SO_4. Be sure to consider determine the reactant that is the limiting reactant.

$$Al\,(s) + H_2SO_4\,(aq) \longrightarrow Al_2(SO_4)_3\,(aq) + H_2\,(g)$$

ANSWERS:
1 a) 0.057 mol b) 3.1×10^{23} c) 0.00697 mol d) 3.0 g 2a) 4.4g b) 76.0% Ti, 22.0% O c) 641 g
3. a) Na - 43.4%, C - 11.3%, O - 45.3% b) Al - 53.0%, O - 47.0%
4. a) NO_2 b) P_2O_5 5. $C_2H_4O_2$ 6. $C_6H_6O_3$ 7. $C_3H_7O_3$
8. 5.6 g9. a) 2.6 kg b) 1.13 kg 10. a) 102 g b) 143g FeS
11. a) 21.9 g b) 93.6 % 12. 15.1 g

MORE PRACTICE:

For the following questions, use the equation describing the combustion of butane:

$$4\,C_4H_{10} + 13\,O_2 \rightarrow 8\,CO_2 + 10\,H_2O$$

20. Define limiting and excess reactants.
21. If 12.6 mol of butane is combusted in excess oxygen, what amount of carbon dioxide is produced?
22. If 8.42 mol of oxygen is used to combust excess butane, what amount of water is produced?
23. If 3.25 mol of butane is combusted in excess oxygen, what mass of water is produced?
24. What mass of oxygen is needed to fully combust 1.46 mol of butane?
25. If 9.44 g of butane is combusted in excess oxygen, what mass of carbon dioxide is produced?
26. What mass of oxygen is required in order to produce 10.0 g of water?
27. If 4.67×10^{24} molecules of oxygen is used combust excess butane, what number of carbon dioxide molecules are produced?
28. How many oxygen molecules are required to fully combust 1.21×10^{25} molecules of butane?

29. If 24.4 g of butane is combusted in excess oxygen, what number of water molecules are produced?
30. If excess butane reacts with 6.28×10^{24} molecules of oxygen, what mass of carbon dioxide is produced?
31. If 14.2 mol of butane and 85.6 mol of oxygen are present, which is the limiting reagent?
32. If 2.22 mol of butane and 15.2 mol of oxygen are present, which is the limiting reagent?
33. If 9.2 g of butane and 29.1 g of oxygen are present, which is the limiting reagent?
34. If 36.7 g of butane and 141.8 g of oxygen are present, which is the limiting reagent?
35. What is the difference between theoretical yield, actual yield and percentage yield? Show their relationship.
36. What does actual yield not always equal theoretical yield?
37. In an experiment, 12.37 g of carbon dioxide was produced when 14.25 g was predicted. What is the percentage yield? *]*
38. In an experiment, 86.2 g of oxygen was produced when 79.4 g was predicted. What is the percentage yield?
39. A reaction starts with 7.21 mol of butane and 617.2 g of water was produced. What is the percentage yield?
40. In an experiment, 82.4 g of oxygen was burned with excess butane and 59.6 g of carbon dioxide was produced. What is the percentage yield?
41. A reaction occurs between 18.1 g of butane and 1.05×10^{25} molecules of oxygen. What is the limiting reagent?
42. A reaction occurs between 2.41×10^{22} molecules of butane and 6.4 g of oxygen. What is the limiting reagent?
43. A reaction occurs between 100 g of butane and 100 g of oxygen. The reaction has a percentage yield of 71.3%. What mass of carbon dioxide is produced?

Answers:

28. *50.4 mol*
29. *6.48 mol*
30. *293 g*
31. *304 g*
32. *28.6 g*
33. *23.1 g*
34. *2.87×10^{24}*
35. *7.86×10^{25}*
36. *1.26×10^{24}*
37. *282.5 g*
38. *oxygen*
39. *butane*
40. *oxygen*
41. *butane*
44. *86.81%*
45. *109%*
46. *95.0%*
47. *69.7%*
48. *butane*
49. *oxygen*
50. *60.3 g*