Limiting Reactant

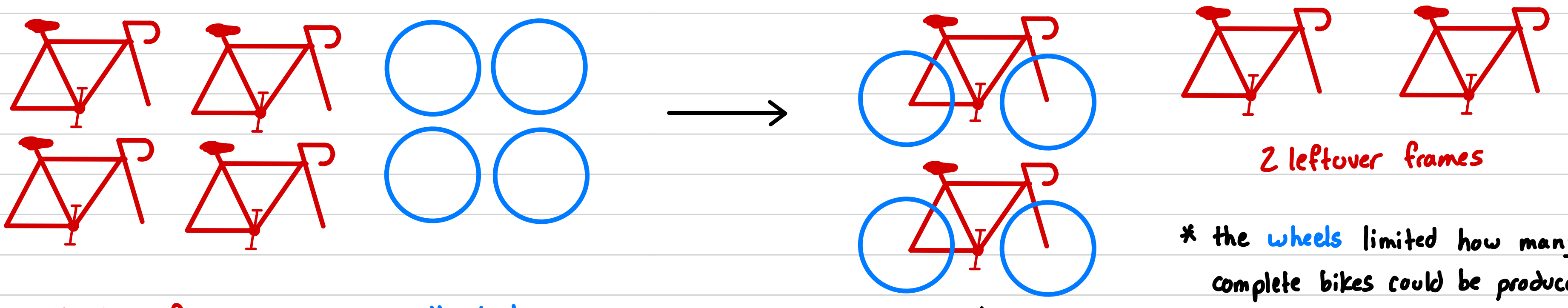
When more than one reactant takes place in a chemical reaction, they will break apart and reform into products

↳ unless there is exactly the same amount of each, one reactant will be completely consumed and one will be leftover

limiting reactant: the reactant completely used up in a chemical reaction. The amount of product is limited by the quantity of this reactant

excess reactant: the reactant remaining after the completion of a chemical reaction.

ex:



* the wheels limited how many complete bikes could be produced
∴ wheels are limiting reactant

↳ by determining which reactant is limiting allows a calculation of theoretical maximum yield.

Example problems

(i) ~ Determining limiting and excess reactants ~

50.0g of N_2H_4 is reacted with 75.0g of N_2O_4 to produce water and N_2. Determine the limiting and excess reactants.

(ii) ~ Determining how much product can be produced and how much of excess will be left over ~

a) How many grams of lead (II) chloride are produced from the reaction of 15.3g of NaCl and 60.8g of $Pb(NO_3)_2$?

b) How many grams will be left over of the excess reactant?

Limiting Reactant cont.

(iii) ~ Determining maximum yield of product given limiting reactant ~

3 mol of C_3H_8 is reacted with excess oxygen (O_2). Determine the maximum mass of CO_2 and H_2O that can be produced

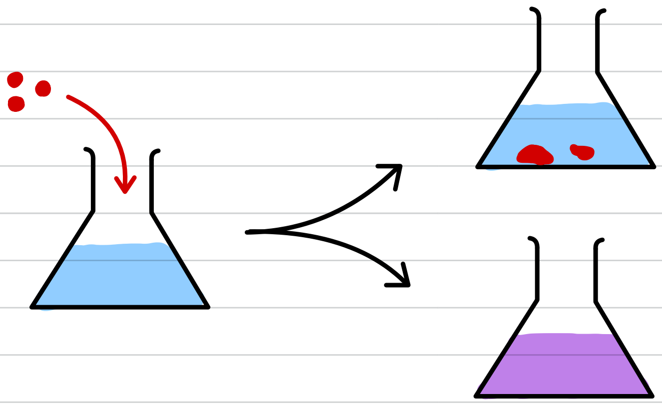
(iv) ~ Determining maximum yield ~

Calculate the maximum mass of $AlCl_3$ that can be produced from a reaction of 2.80g of aluminum and 4.15g of chlorine gas.

Solutions

solute: substance being dissolved

solvent. substance in which solvent dissolves



heterogeneous solution : solution with non-uniform composition
ex: oil and water

homogenous solution : solution with uniform composition
ex: salt water, hydrochloric acid

★ in order to speed up dissolving : ① mix the solution - helps distribute solute particles within solvent
② heat the solution - more kinetic energy, ∴ solutes collide and interact with solvent more

★ **saturated solution** : the maximum amount of solute dissolved within solvent. Adding more solute beyond this will not dissolve

concentration : quantity of moles (n) or grams dissolved in one dm^3 (L) of solution

concentration (mol/L or g/L) → $\boxed{C = \frac{n}{V}}$ ← moles (mol) or mass (g) of solute
← volume (L) of solution

molar concentration, M — mass concentration

$\boxed{1\,L = 1000\,mL = 1000\,cm^3 = 1\,dm^3}$

Example problems

(i) ~ calculating molar concentration ~
A saline solution contains 0.90 g NaCl dissolved in 100 mL of solution. What is the molar concentration?

(ii) ~ calculating mass and molar concentration ~
0.5 g of calcium hydroxide is added to 10 mL of water. What is its mass concentration ($g\,dm^{-3}$) and molar concentration ($mol\,L^{-1}$)?

(iii) ~ calculating amount of solute (grams) ~
A saturated solution of $CaSO_4$ (aq) has a concentration of 0.0154 mol/L.
A student takes 65 mL of the solution and evaporates it. What mass is left?

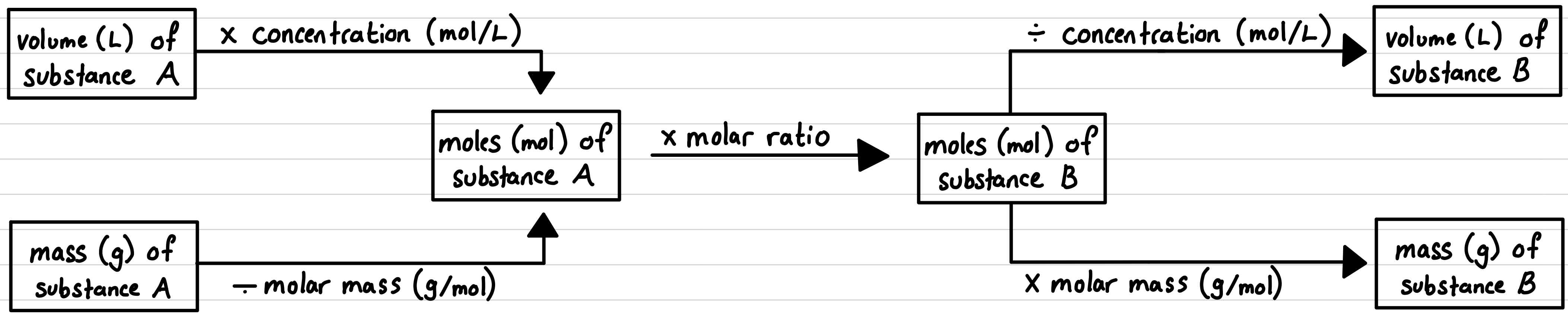
(iv) ~ calculating amount of solute (grams) ~

Determine the mass of solute present in a 500 cm^3 solution of 0.100 $mol\,dm^{-3}$ silver nitrate.

(v) ~ calculating solution volume ~

What volume of 0.25 mol/L solution can be made using 14g of sodium hydroxide?

Solution Stoichiometry



Example problems

(i) ~ calculating product mass from reactant ~

Calcium chloride reacts with phosphoric acid (H_3PO_4) to produce calcium phosphate and hydrochloric acid, HCl.
How many grams of calcium phosphate can be produced if 2500 cm^3 of 0.250 M calcium chloride reacts with excess phosphoric acid?

(ii) ~ calculating reactant volume ~

How many mililiters of 1.50 M nitric acid (HNO_3) is required to react with 100.0g of cuprous oxide in the following unbalanced equation:

$$HNO_3 + Cu_2O \longrightarrow Cu(NO_3)_2 + NO + H_2O$$

(iii) ~ calculate concentration of reactant ~

60.5 cm^3 of HNO_3 are required to react with 25.0 mL of 1.00 M $Ba(OH)_2$ solution to produce barium nitrate and water.
What is the molarity of HNO_3 solution?