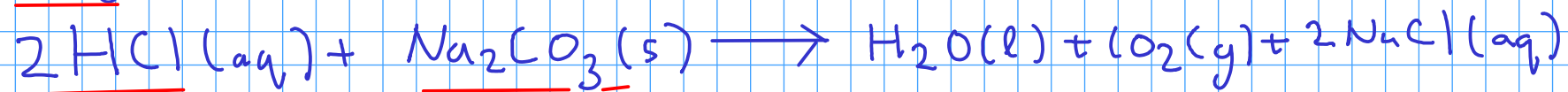


Example:

How many milliliters of 6.00M hydrochloric acid is needed to completely react with 25.0 g of sodium carbonate?

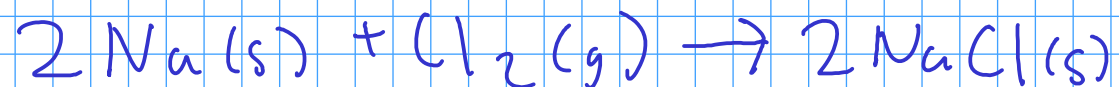


- 1 - Convert 25.0 g of sodium carbonate to moles. Use formula weight.
 - 2 - Convert moles sodium carbonate to moles hydrochloric acid. Use chemical equation.
 - 3 - Convert moles of hydrochloric acid to volume. Use concentration.
-

$$\begin{aligned} \textcircled{1} \text{Na}_2\text{CO}_3: & \quad \text{Na} : 2 \times 22.99 \\ & \quad \text{C} : 1 \times 12.01 \\ & \quad \text{O} : 3 \times 16.00 \\ & \quad \hline & \quad 105.99 \text{ g Na}_2\text{CO}_3 = \text{mol Na}_2\text{CO}_3 \end{aligned}$$

$$25.0 \text{ g Na}_2\text{CO}_3 \times \frac{\text{mol Na}_2\text{CO}_3}{105.99 \text{ g Na}_2\text{CO}_3} = 0.2358713 \text{ mol Na}_2\text{CO}_3$$

EXAMPLE PROBLEM:



How many grams of sodium metal is required to completely react with 2545 grams of chlorine gas?

- 1- Convert 2545 g of chlorine to moles using formula weight
 - 2 - Convert moles chlorine to moles sodium using chemical equation
 - 3- Convert moles sodium to grams using formula weight
-

$$\textcircled{1} \text{ Cl}_2: 2 \times 35.45 = 70.90 \text{ g Cl}_2 = \text{mol Cl}_2$$

$$\textcircled{2} 2 \text{ mol Na} = \text{mol Cl}_2$$

$$\textcircled{3} \text{ Na}: 22.99 \text{ g Na} = \text{mol Na}$$

$$2545 \text{ g Cl}_2 \times \frac{\text{mol Cl}_2}{70.90 \text{ g Cl}_2} \times \frac{2 \text{ mol Na}}{\text{mol Cl}_2} \times \frac{22.99 \text{ g Na}}{\text{mol Na}} = 1650. \text{ g Na}$$

$\textcircled{1} \qquad \qquad \qquad \textcircled{2} \qquad \qquad \qquad \textcircled{3}$

EXAMPLE PROBLEM:



How many mL of 0.250 M sodium hydroxide is required to completely react with 15.0 mL of 2.00 M sulfuric acid?

- 1 - Convert volume of sulfuric acid to moles using concentration.
- 2 - Convert moles sulfuric acid to moles sodium hydroxide using chemical equation
- 3 - Convert moles sodium hydroxide to volume using concentration

To deal with mL and L: $\text{mL} = 10^{-3}\text{L}$

① $2.00 \text{ mol H}_2\text{SO}_4 = \text{L}$ ② $\text{mol H}_2\text{SO}_4 = 2 \text{ mol NaOH}$

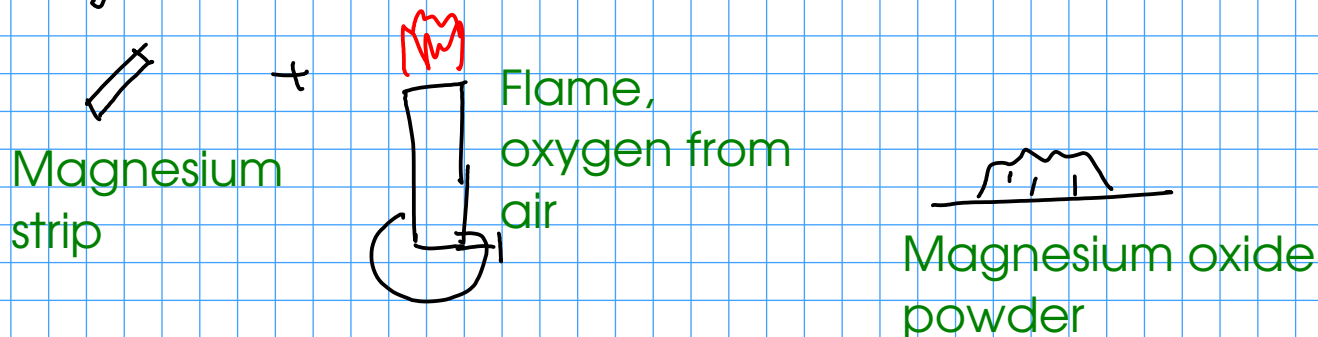
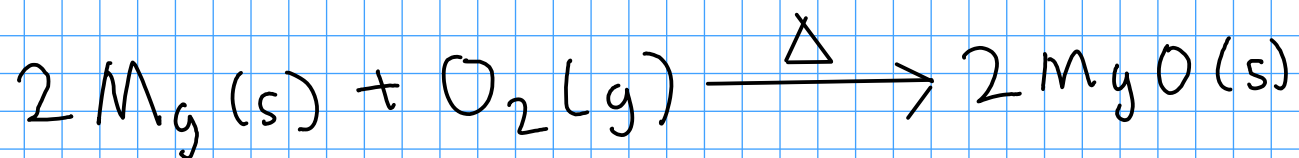
③ $0.250 \text{ mol NaOH} = \text{L}$

$$15.0 \text{ mL} \times \underbrace{\frac{10^{-3} \text{ L}}{\text{mL}} \times \frac{2.00 \text{ mol H}_2\text{SO}_4}{\text{L}}}_{\text{①}} \times \underbrace{\frac{2 \text{ mol NaOH}}{\text{mol H}_2\text{SO}_4}}_{\text{②}} \times \underbrace{\frac{\text{L}}{0.250 \text{ mol NaOH}}}_{\text{③}} \times \frac{\text{mL}}{10^{-3} \text{ L}} =$$

$$= \boxed{240. \text{ mL of NaOH solution}}$$

CONCEPT OF LIMITING REACTANT

- When does a chemical reaction STOP?



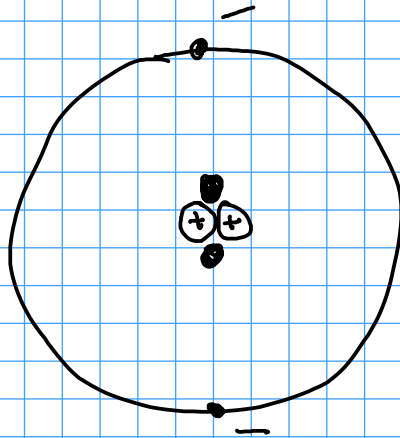
- When does this reaction stop? When burned in open air, this reaction stops when all the MAGNESIUM STRIP is gone. We say that the magnesium is LIMITING.

- This reaction is controlled by the amount of available magnesium

- At the end of a chemical reaction, the LIMITING REACTANT will be completely consumed but there may be some amount of OTHER reactants remaining. We do chemical calculations in part to minimize these "leftovers".

- Reactants that are left at the end of a chemical reaction (in other words, they are NOT the limiting reactant) are often called "excess". So reacting magnesium with "excess oxygen" means that magnesium is limiting.

STRUCTURE OF THE ELECTRON CLOUD



The nuclear model describes atoms as consisting of a NUCLEUS containing protons and neutrons and an ELECTRON CLOUD containing electrons.

The ELECTRON CLOUD is described as being a diffuse (lots of empty space) region of the atom. Nothing else about it is part of the nuclear model.

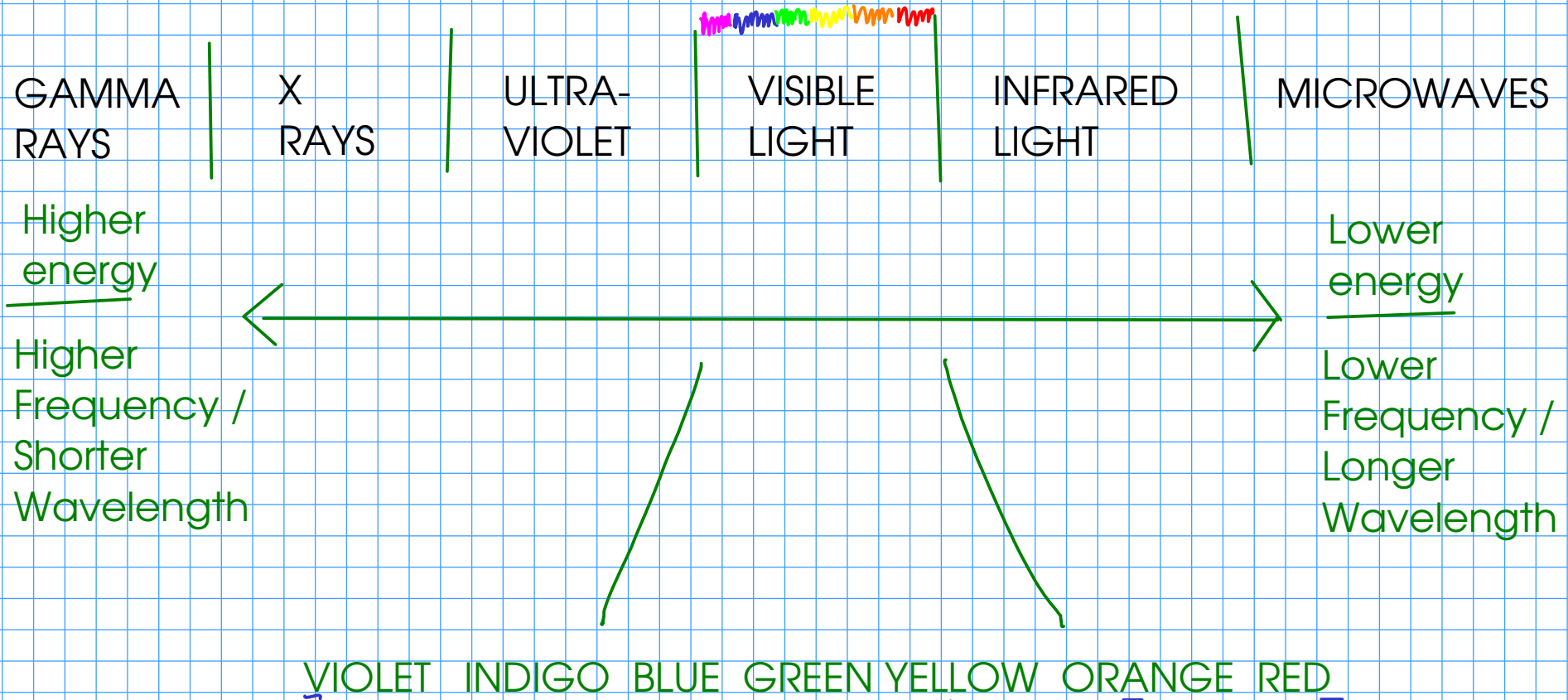
... but the nuclear model is not useful to explain several things:

- Does not explain why atoms react differently from one another
- Does not explain how atoms emit and absorb light (atomic line spectra)

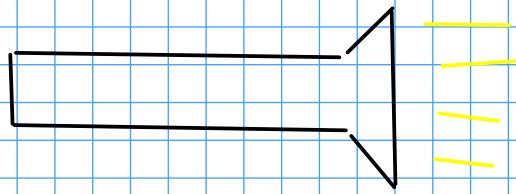
ELECTROMAGNETIC SPECTRUM

(see p304-306)

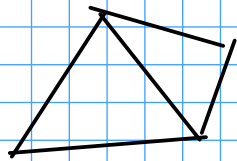
- Different kinds of "light" have different energy contents



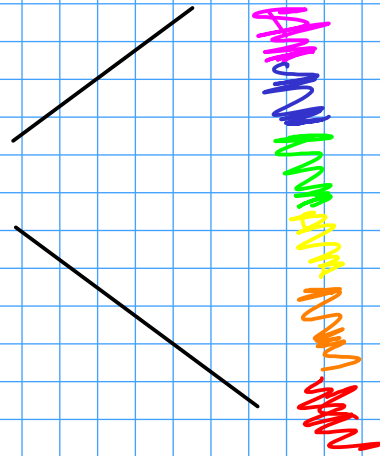
- Different colors of visible light correspond to different amounts of energy



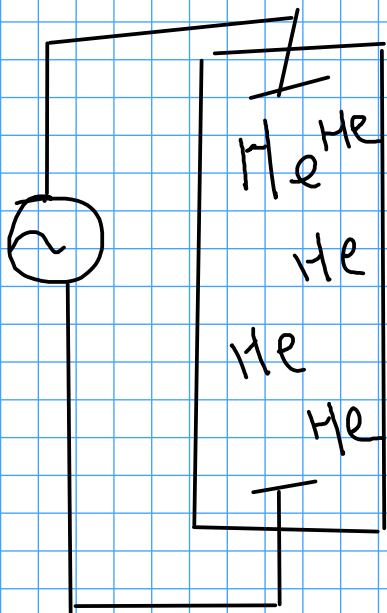
Source of white light



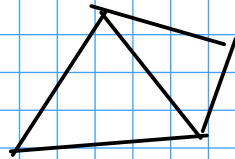
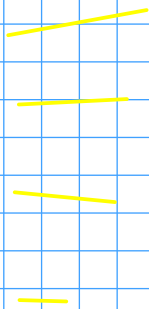
Prism



Rainbow (all colors represented)



Gaseous Helium excited by electricity



Prism



LINE SPECTRUM - only a few specific colors appear!