# Chemistry Guidebook Semester 1 2024

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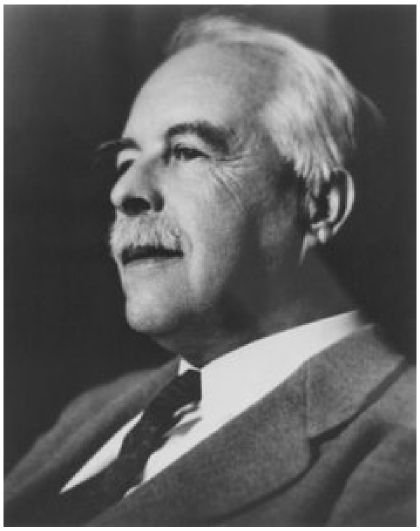
5 December 2024

## 1 Introduction

This will be a quick guide book on doing all topics of chemistry for the period of the first semester. This will include topics such as chemical bonding to equilibrium. This guidebook will contain simple explanations of the topic, formulas, and if needed, example questions. Please do take this with a grain of salt, I am not a professional educator, just some bored dude who needs to study hence I'm explaining through this PDF, if there are mistakes, please correct them yourself. With this finished, enjoy the learning process...!

## 2 Chemical Bonding

For starters, the basics of all chemistry topics, being chemical bonding. In the year 1916, Gilbert Newton Lewis and Albrecht Kossel stated that elements want to be stable like the noble gases, to stabilise it to be like the noble gases, they have to gain/give electrons. Kossel stated that all electrons want an octet, or 8 electrons on the valence shell of the atom. I assume you already know how valence electrons work, and it is important you know the symbols of an cation and anion, a cation being a positively charged element (mostly metals) with less electrons than the usual element, for example being calcium $Ca^{+2}$, because the atomic number is 20, and it want to be like a noble gase (search one up for reference) it gives away 2 electrons, and the opposite being for example $Cl^{-}$ where it receives 1 electron to make it 18 electrons.



(a) Gilbert Newton Lewis

(b) Albrecht Kossel

### 2.1 Ionic Bonds

An ionic bond is when a metal and a non-metal react. This is when a metal gives away 1 electron and the non-metal receives 1 electron, an example will be

$$NaCl$$

Being table salt, where $Na^+$ wants to give away 1 electron to the $Cl$ to make them both stable. It is one of the most strongest bonds out of the 3. This is also known as an electrostatic attraction.

#### 2.1.1 Characteristics of an Ionic Bond

Ionic bonds, when dissolved in water to be an aqueous solution can conduct electricity this also happens when they're melted. This is because the ions of the compound can move freely around (place to place), unlike when they're solid.

Next, they have an high melting point, this is because of its strong ionic attraction holding together, making alot of energy needed to melt these bonds.

Because water has 2 poles, it can break apart ionic bonds fairly easily, hence it is easy and possible to dilute ionic bonds in water.

## 2.2 Covalent Bond

Covalent bonds are when 2 non metal elements react and shares an electron, since atoms will always want to be stable like noble gases. Examples include $H_2$, $O_2$, $CH_4$

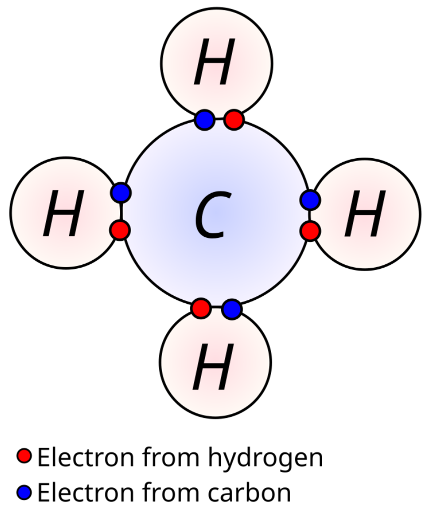



Figure 2: $CH_4$, being Methane.

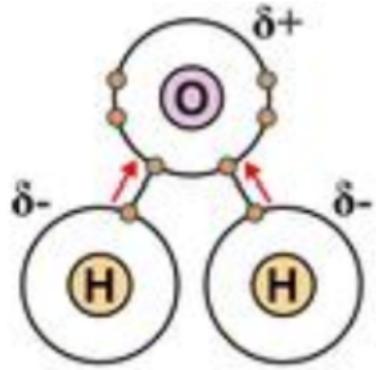
### 2.2.1 Characteristics of a Covalent Bond

Because covalent bonds are fixed together by sharing electrons, there aren't any free movement in the compound, hence conduction isn't possible.

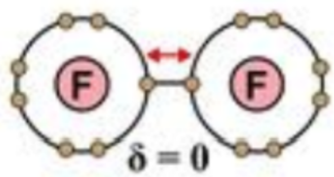
Because of weak intermolecular forces in the covalent bond, while it is a strong bond, it has fairly weak forces so it doesn't require a lot of heat to melt covalent bonds, that is why most covalent bonds are in liquid/gas when in room temperature (20°)

### 2.2.2 Types of Covalent Bonds

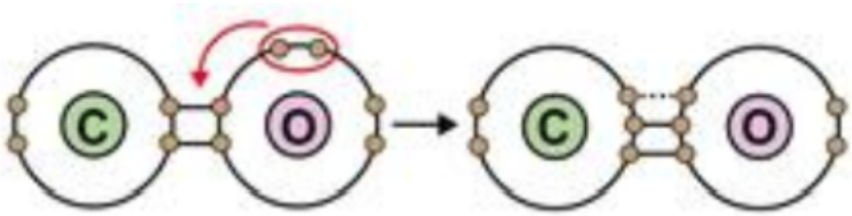
Polar bonds, where one side has more electrons than the other.




Non polar bonds, where both sides of the bond have the same amount of electrons

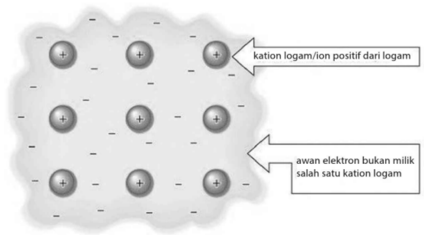



Coordinate bond (dative bond), where all the electrons are given to another atom




## 2.3 Metallic Bond

Metallic bonds are when two metals react with each other, surrounded by delocalized electrons from other shells where strong electrostatic forces exist between the metal ions and the delocalized electrons.




### 2.3.1 Characteristics of Metallic Bonds

Because delocalized electrons are free to move around and pass around thermal and electric energy, this makes bonds that are metallic good to conduct heat and electricity with.

Because of the strong electrostatic force between he ions and the delocalized electrons, this makes the temperature to melt metallic bonds very high.

It is malleable because the structure makes the layers possible to stack on top of each other, hence it can be hammered into place with ease.

Its lustrous, or the common term, shiny. Caused because delocalized electrons on the surface of the metal.

## 2.4 Intermolecular Bonds

| Bond Type | Relative Strength |
|---|---|
| Ionic and covalent bonds | 1000 |
| Hydrogen bonds | 50 |
| Dipole-dipole forces | 10 |
| Van der Waals' forces | 1 |

## 2.5 Dipole-Dipole

A weak attractive force between permanent dipoles in neighbouring polar molecules, where all polar molecules have permanent dipoles

| Noble Gas | | No. of electrons |
|---|---|---|
| He | -269 | 2 |
| Ne | -246 | 10 |
| Ar | -186 | 18 |
| Kr | -153 | 36 |
| Xe | -108 | 54 |
| Rn | -62 | 86 |

### 2.6 Van der Waal's

Acting between very small temporary dipoles in neighbouring molecules.

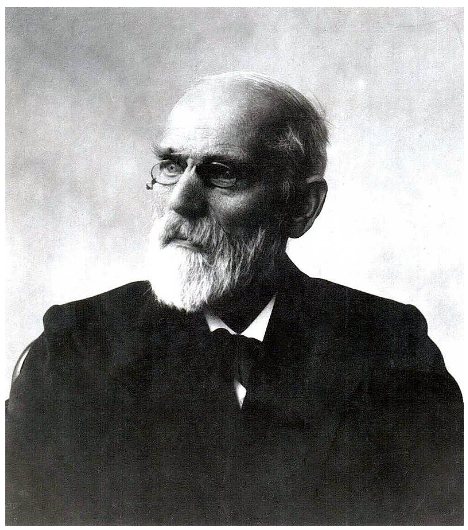


Figure 3: Johannes Diderik van der Waals

When the number of electrons increase, the boiling point and van der Waals' forces increase.

### 2.7 Hydrogen Bonds

Hydrogen Bonds are bonds of hydrogen with very electronegative elements (F, O, N) an example is $HF$

## 3 Stochiometry

Formula list, just assume if not given 100 ml = 100 gr = 100 Percent. I assume you can do the M-R-S table, I can't right now on computer because no drawing tab.

$$n = \frac{m}{Ar/Mr}$$

Where n is the moles, m is the mass, and Ar/Mr is the atomic mass or the molecular mass.

$$M = \frac{n}{V}$$

Where M is the molarity, where n is the moles, and V being the volume in $l$

$$X_1 = \frac{n_1}{n_1 + n_2}$$
$$X_2 = \frac{n_2}{n_1 + n_2}$$

Where $X_1$ is the molal fraction of the solute and $X_2$ being for the solution.

$$M_1 V_1 = M_2 V_2$$

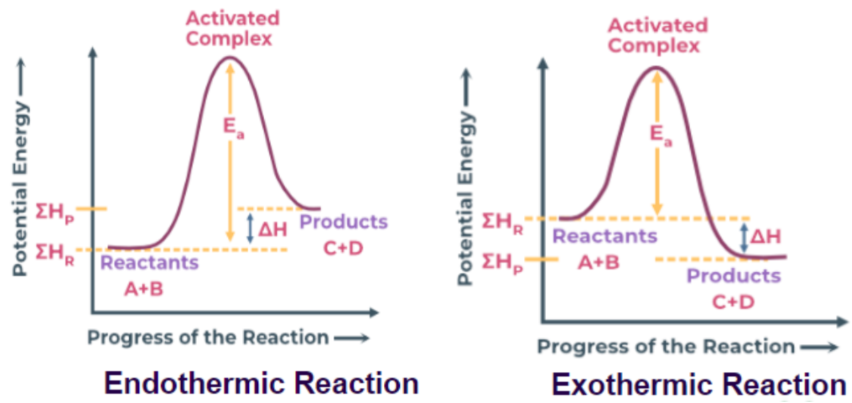
No, not momentum. Dilution, add more solvent without adding more solute. $M_1$ is the initial molarity and $V_1$ being the initial volume.

$$M_m = \frac{n}{m}$$

$M_m$ being Molality, amount of solute. moles dissolved per 1 kg of solvent.

I assume you already know how to find the amount of water in an ionized salt, if not just find moles of both sides then ratio then both to be 1:x

# 4 Thermochemistry




Activation energy is the energy required to break bonds in the reactants for the reaction to occur.

## 4.1 Endothermic

Endothermic reactions are reactions where the heat is absorbed by the system (reaction), the product. It will make the surroundings colder.

$$6C_6 + H_2O + E \rightarrow C_6H_{12}O_6 + 6O_2$$

Or it can be defined by this

$$6C_6 + H_2O \rightarrow C_6H_{12}O_6 + 6O_2 \Delta H = +XkJ$$

## 4.2 Exothermic

Exothermic reactions are reactions where the heat is released by the system, the product, making surroundings colder.

$$CH_4 + 2O_2 \rightarrow CO_2 + H_2O + E$$

Or,

$$CH_4 + 2O_2 \rightarrow CO_2 + H_2O \Delta H = -XkJ$$

### 4.3 Properties of Thermochemistry

This will be useful for the Hess' Law.

$$2H_2 + O_2 \rightarrow 2H_2O\Delta H = -286kJ$$

Using the extensive property, it can become

$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O\Delta H = \frac{-286}{2}kJ$$

The next one depends on physical state. It can change the $\Delta H$ a lot.
This one is reversible

$$H_2O \rightarrow H_2 + \frac{1}{2}O_2\Delta H = +143kJ$$

$$X = \frac{mole}{\Delta H}$$

Using the distributive property, it allows us using ratio to find the amount of energy is produced with the mole of something.

### 4.4 Entalphy Change

Entalphy change when you're just inputing numbers.

$$\Delta_f H = \Sigma\Delta_f H(product) - \Sigma\Delta_f H(reactants)$$

When you're using bonds (lewis structure)

$$\Delta H_r = \Sigma H(reactants) - \Sigma H(products)$$

Note: Some of the $\Delta H_f$ of some compounds being $O_2$ and $H_2$ is just 0.

### 4.5 Hess' Law

Using more reactions, it can help determine the entalphy change by eliminating reactions.

$$
\begin{array}{llll}
 & C(s) + 1/2O_2(g) \ \square\ \cancel{CO(g)} & & \Delta H = -111\ kJ \\
+ & \cancel{CO(g)} + 1/2O_2(g) \ \square\ CO_2(g) & & \Delta H = -283\ kJ \\
\hline
 & C(s) + O_2(g) \ \square\ CO_2(g) & & \Delta H = -394\ kJ
\end{array}
$$

### 4.6 Heat Capacity

$$Q = mc\Delta T$$

Where m is the mass, c is the specific heat capacity, and $\Delta T$ is the change of temperature.