Lesson 2 For Book 1C

Corrosion of metals

In the presence of air, water or other substances (to be discussed later in this note) in the surroundings, metals will gradually be deteriorated. The process is called **corrosion**.

Reminder = 1) Corrosion has a wider meaning than rusting, as **rusting** can be used only for the **corrosion of iron**.

2) Corrosion/rusting is a chem____ change, which involves a reaction.

How does rusting happen?

In fact, it is a slow/fast? process and an **exothermic** reaction in nature, which will release heat to the surroundings. Basically, it involves the o_____________ of iron first. → **REDOX reaction**.

$$Fe\ (s) \dashrightarrow Fe^{2+}(aq) + 2e^-$$

Then, **a series** of redox reaction happens, in which the oxidation of Fe^{2+} (reduction of oxygen) happens with the formation of Fe^{3+} afterwards .

$$4\ Fe^{2+} + O_2 \rightarrow 4\ Fe^{3+} + 2\ O^{2-}$$

Finally, due to the presence of **water**, we have

$Fe^{2+} + 2\ H_2O$ □ $Fe(OH)_2 + 2\ H^+$ and $Fe^{3+} + 3\ H_2O$ □ $Fe(OH)_3 + 3\ H^+$

Most importantly, the **overall equation** can be represented by

$$\boxed{4Fe(s) + 3O_2(g) + 2nH_2O(l) \dashrightarrow 2Fe_2O_3\ nH_2O\ (s\ ,\ reddish\ brown)}$$

Ways to speed up the rusting

1. Adding metals in an a_____ solutions (vs. **Alkaline** solutions can s____ down the rusting. Why?)
2. Adding metals in a solution in the presence of soluble salts, i.e., an **electrolyte** e.g. NaCl
3. **Heat** the contacting solution up --- increasing the temperature (→ this speed up many reactions.)
4. Presence of a **less** r____________ metals in contact with iron and

   the presence of uneven/ sharply pointed/ scratched regions.

How to observe the rusting process? --- Rust indicator

Rust indicator contains $K_3[Fe(CN)_6]$. It can detect the presence of ___ ions since Fe^{2+} ions can turn the rust indicator from yellow to blue.

How to prevent rusting? (Please try to memorize them all)

1) Coating with paint, plastic, oil or grease so as to prevent the contact with a____ and water moisture.
2) Galvanization --- coat metal with zinc as Zn can form a protective oxide layer.
3) Tin-plating Electroplating
4) Cathodic protection --- suppress the redox reaction by preventing metals from losing e^-.
5) Sacrificial protection --- the more ________ metal corrodes instead of the less reactive metal.
6) Using alloys of iron --- mix iron with innert substance e.g. c______.
7) Anodization --- For Al only, which involves the thickening of the Al_2O_3 layer.

Extra knowledge --- The **application** of rusting of iron

*Situation: Iron powder can be used to make '**warm packets**' for keeping users' warm. A kind of warm packet is made by putting iron powder in a packet which allows **air** to pass through. The packet aslo contains other substances for speeding up the generation of heat.*

a) According to the situation, using your chemcial knowledge, suggest how the packet can generate **heat**. *

b) Someone suggested that a piece of iron should be used instead of using powder.
Comment on his/her statement.

c) The other substances include moist **sodium chloride**. Suggest why it can speed up the production of heat.

The mole concept --- Basic chemistry

The following parts are vital in studying chemistry.

The **mole concept** is used to define the q________ (amount) of substance in chemical point of view. One mole = 6.02 * 10^23 numbers of particles → Avogadro number **L** in **mol^{-1}**. As you should realise, one 'mole' involves a large number of substance in fact.

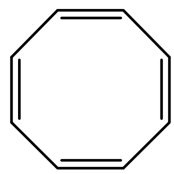
→ **Molar mass** = the mass in grams of ____ mole of the substance. (g mol^{-1}). Actually, **molar** means **per mole**. So, you may expect that molar volume bears the unit dm^{3}____.

Remember : molar mass = mass / no of mole and no. of mole = no of particle / L

→ Be careful of the **unit**.

→

Exercise 1 Given that a cyclooctane, named **1,3,5,7-Cyclooctatetraene,** which is an organic compound, has the following structure.



a) What is the molecular formular of it?

b) What is the molar mass of it? (Unit is required)

c) If there is 10g of the compound, how many "no of molecule" (not no. of mole) are there?

(C_8H_8, 104.15 g/mol, 5.78*10^22)

Chemical Formulae of compounds

Actually, we need to learn about the empirical, ionic, molecualr and structural formula of compounds, mainly for o______ speices.

1) Empirical Formula

The formula which shows the simpest whole number ratio of the atoms or ions present.

→ In fact, empirical formula of an organic sample (What is it? It is those compounds containing the elements of _______ , ________) is found by the combustion of the sample, i.e. complete combustion.

e.g. $(CH_2)_n$ = __________, where n must be an integer.

If n is = 4, ________ is the molecular formula of the compound.

2) Molecular Formula

The formula shows the actual number of each kind of atoms in o____ molecule of the substance.

Exercise 2

Compound 2 has the following composition by mass:

C = 70.6% H = 5.9% O = 23.5%

i) Please find out the empirical formula of L.

(Hint : Draw the table to calculate the no. of moles of each atom→simplest ratio)

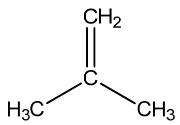
ii) Given that its rel. molecular mass is around 136, what is its **molecular formular**?

(C_4H_4O, $C_8H_8O_2$)

3) Structural Formual

The formula which shows how the constituent a_____ are joined up in one molecule of the substance. It is the most important one as it can enable us to find the exact structure of a sample. But it can be **hardly** found.

→ As for the above example, C_4H_8 represents a lot of possible compounds, e.g.



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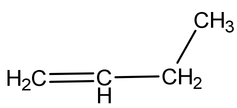

, , (a ring)

→ To draw the actual structure, we need to determine the s___________ formula.

4) Ionic Formula

The formula which shows the simplest whole number ratio of the ions present, and also the charges carried by them. It is used for i____ compound **only**.

Exercise 3 *** A tricky question

Assume that Magnesium Nitride $\mathbf{Mg_3N_2}$ (a greenish yellow powder) is completely soluble in water.

a) Draw the electron diagram of Mg_3N_2 . (show the outermost electrons only)

b) What is the molar mass of the Mg_3N_2 ?

***c) How many moles of Mg^{2+} ions and N^{3-} ions are there in 10g of Mg_3N_2 in 1mL water?

→ According to the ionic formula of Mg_3N_2 , the no. of moles of the Mg^{2+} and N^{3-} ions should ____ be the same. (100.9494 g/mol , cation= 0.297, anion= 0.198 mol)

Importance of A chemical equaiton

$$N_2\,(g) + 3H_2\,(g) \xrightleftharpoons{Fe_2O_3\,(s)\,,\ 1000^oC,\ 500\ atm} 2NH_3\,(g)$$

Consider the equation representing the Haber Process, i.e. the production of a__________ .

In an equation, we have the information about the reactants , p__________ , the **reversibility** of a reaction and the **conditions** required for the reaction e.g. t____________, p__________ and the presence of **catalyst.**

(What is it? Positive Catalyst is the substance which can speed up the reaction by providing a reaction pathway with a l_____ **activation energy**.

→ Noted that Ea is the minimum energy barrier for a r______ to happen.)

Most importantly, we have the information about the **Stiochiometry,** i.e., the indication of the no.of species reacting. Studying the coefficients can help you deal with the **mole concept**…and the determination of "**limiting agent**".

Question : how many moles of hydrogen is required to form 2 moles of ammonia? _____.

Exercise 4

6.0 grams of C_2H_2 and an unknown supply of oxygen are used in combustion. To produce as much CO_2 as possible, how much grams of oxygen should be added to the reaction?

Hint = $2\ C_2H_2(g) + 5\ O_2(g) \text{--->} 4\ CO_2(g) + 2\ H_2O(l)$ (18.5 grams)