From the writer

To learn chemistry better, you should:

1) Understand the Periodic Table thoroughly. *2) Remember the **definitions** of some important terms.

3) Do exercises after revision. 4) Write your own set of notes.

Lesson 1 For Book 1C --- Metals

Usages of Metals

- Metals have a lot of daily applications. For example, I____ can be used for constructing building, C_____ for making electrical wires, A_____ for making soft drink cans, Titanium for making aircrafts and G_____ / S_____ for making coins

→ Metals can serve human for the above usages because metals have the following **physical properties**.

1. Hard / strong 2. Malleable and ductile
3. corrosion resistance 4. Light
5. Good conductor of h____ and e_____ (WHY?)

- To explain the reason **why** metals have such properties, we can consider their structure by

Electron sea model --- Features needed to be remembered

1) To construct the **lattice** of metal, metal **atoms loses** their v_____ electrons to form **c**_____ .

(Remember = the no. of **valence electrons** is equal to the **group number**.

e.g. *Sodium* has ____ valence electron while *Calcium* has ___ valence electrons)

2) The electrons move freely around the cation lattice and hence form the **electron sea**.

→ metals are thus able to conduct e_____

3) There exists **ionic** attractions between the **free electrons** (or delocalized electrons) and the metal c_____. These attractions form the strong **metallic bond** and thus, metals are strong, hard, ductile.

Extraction of Metals

- **Mechanical separation ---** For very stable metals only, e.g gold.
- **Heating the metal ore alone ---** For extracting un_____ metals **only**, e.g mercury and silver.

→ Actually, **metal ore** is usually a metal oxide.

→ So, from metal oxide to metal, this process is a R_____ . (e.g. Silver oxide → silver + ___)

- **Carbon R_____** --- Upon heating with carbon, some metals can be extracted from their ore. e.g iron and lead and zinc.

Illustration : For iron

The carbon reduction takes place in a blast furnace (Large scale). The **flow** of reduction is

→ Coke (carbon) is oxidized to CO

→ CO (g) acts as the r_____ agent to reduce metal ore (metal oxide) to m_____.

i.e. Fe_2O_3 (a mixture of Fe(2, 3) oxide) + CO(g) --> Fe(s) + CO_2 (g)

- **Electrolysis** --- The most expensive but efficient method to extract more r_____ metals e.g. Na, ____ ,K, Ca, Al → Redox reaction is involved

Illustration : For the extraction of sodium from sodium chloride

Cathode (- pole) = $Na^+(aq) + e^- \rightarrow Na(s)$ → pure Sodium can be extracted

Anode (+ pole) = $2Cl^- \rightarrow Cl_2 + 2e^-$ → pure chlorine is produced

Reactivity of Metals

- By definition, **reactivity** is the **readiness** of metals to react with others. In other words, we have :
  - → the more the reactive the metal is, the **less stable** it is
  - → the more the reactive the metal is, the **faster** will be the reaction
  - → the more the reactive the metal is, the **lower amount of energy** is required.
  - → the more the reactive the metal is, the **larger amount of energy** (heat) is released.
  - → the more the reactive the metal is, the **easier to lose electrons**. ***
- For **metals**, going down the g_____ , R⇧ ; Across the p_____, R ↓ ***

Example 1 ***Burning in Air***

Reactivity order =*K > Na > Ca > Mg > Al* > Zn > Fe > Pb > Cu > Hg > Ag > Pt > Au

→ Observations for the *first five* = *Lilac flame, golden yellow flame, brick red flame, very bright white flame, heat and white powder*

→ Observations for the next five = *heat and yellow powder when hot while white when cold, yellow sparks with black solid, powder (orange when hot and yellow when cold) formed, turns black, red powder formed*

→ No observations for the last three.

Example 2 ***Reacting with water***

Reactivity order = *K> Na > Ca* > *Mg > Al* > Zn > Fe > Pb > Cu > Hg > Ag > Pt > Au

→ *K, Na and Ca* can react with c_____ water to give metal _____ and hydrogen,

where **hydrogen gas** can be tested with a b_____ splint, with a _____ sound.

→ Mg, Al, Zn and Fe can react with steam (h_____ water) to give metal _____ and hydrogen.

→ The remaining ones have no reaction.

→ Question : *Why do we need to store sodium in paraffin oil?*

Example 3 ***Reacting with dilute and cold acid***

Reactivity order =*K > Na > Ca > Mg > Al* > Zn > Fe > Pb > Cu > Hg > Ag > Pt > Au

→ K and Na react with acid explosively to form **salts** and hydrogen

(K has hissing sound and _____ flame while Na has a _____ flame)

→ Ca, Mg, Al, Zn, Fe and Pb can react with acid very slowly.

→ The remaining ones have no reaction.

→ Question : What is the type of the reaction between metal and acid?

It's called Acid Base reaction but not neutralization.

Chemical Equations

- Full equation or ionic equation

e.g.1 Please write down the equations for the reaction between **Lithium and oxygen**

→ Full= → Ionic = XXX because Li_2O is in_____ in water.

e.g.2 Please write down the ionic equation for the **neutralization** process

→ $H^+ + OH^- \rightarrow H_2O$ **Basically, the ionic eqt for 'all' neutralization is the same.

Types of reactions for metals

1. **Oxidation and Reduction** --- involves the transfer (lose and gain) of e_____
2. **Acid and Base reaction** --- likely to be an **exo**_____ reaction which will give out h____
3. **Metal Displacement** --- A metal with higher reactivity (M_1) will displace any metals with lower reactivity (M_2) from the solution of a compound of M_2.

e.g. Zinc metal plate can displace copper II ions from a solution of copper (II) sulphate

→ full equation =

→ **Observations** are very important = a) the solution will turn from blue to p____ blue

b) the zinc plate will dissolve

c) b____ copper will be formed on the plate.

Exercise 1 Please balance the following equations → To learn the **Stiochiometry** of a reaction.

a) $Al(s) + O_2(g) \rightarrow Al_2O_3(s)$
b) $Cu(NO_3)_2(s) \rightarrow CuO(s) + NO_2(g) + O_2(g)$
c) $KClO_3(s) \rightarrow KCl(s) + O_2(g)$
d) $FeS(s) + O_2(g) \rightarrow Fe_2O_3(s) + SO_2(g)$
e) $NH_3(g) + O_2(g) \rightarrow NO(g) + H_2O(l)$
f) $Mg_3N_2(s) + H_2O(l) \rightarrow MgO(s) + NH_3(g)$
g) $Al(s) + Fe^{2+}(aq) \rightarrow Al^{3+}(aq) + Fe(s)$
*h) $C_2H_6(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$
*i) $C_2H_2(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$ → An organic reaction

Exercise 2 Will there be any reactions? State the equation and observation (s) if there is.

a) A piece of Mg is added to dilute sulphuric acid.

b) A piece of calcium is heated strongly in air.

c) A piece of gold is heated.

d) Sodium oxide powder is heated.

e) An iron nail is added to zinc sulphate solution.

f) A zinc plate is added to iron (II) sulphate solution.

g) Copper powder is added to hot and conc nitrate acid.

Basic Things --- About the atomic structure of an atom

- What are the **basic components** of an atom's nucleus? They are _____, _____, and _____.
- For a (neutral) **atom**, the no. of p_____ must be the same as the e_____.
- Definition of atomic number = **Z** is the no of _____/_____ in the nucleus of the atom.
- Definition of mass number = **A** is the no of _____/_____ and _____ in the nucleus of the atom.
- How about isotope? I_____ are atoms of the same e_____ with the same number of p_____ but different number of _____. Basically, different isotopes should have the **same** physical properties (except for the radio-reactivity) and also chemical properties. However, it is likely that isotopes have a different abundance in the earth.